FIRST FIVE-YEAR REVIEW REPORT
PALERMO WELLFIELD SUPERFUND SITE
TUMWATER, WASHINGTON

CERCLIS ID NO. WAD0000026534

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Approved by: **Date:** 29 Sept 2003

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EXECUTIVE SUMMARY

This report presents the results of the first five-year review of the Palermo Wellfield Superfund Site in Tumwater, Washington. The purpose of this five-year review is to determine whether the remedial actions implemented at the site are protective of human health and the environment. The methods, findings, and conclusions of the review are documented in this report. In addition, this report identifies issues identified during the review and includes recommendations to address them.

The U.S. Environmental Protection Agency (EPA) Region 10 conducted this first five-year review for the Palermo Wellfield Superfund Site. The triggering action for this review is the inception date of the first remedial action at the site, construction of the French drain beginning June 1, 2000. This review is being conducted early so that the protectiveness of the indoor air remedy can be assessed. This five-year review is required because the hazardous substances tetrachloroethene (PCE) and trichloroethene (TCE) remain present at the site above the remediation goal (RG) concentrations selected in the Record of Decision (ROD), preventing unlimited use and unrestricted exposure.

The site is located in a mixed commercial and residential district of the city of Tumwater, Washington. PCE and TCE have migrated in groundwater from two upgradient sources to the Palermo Wellfield, which is a primary drinking water source for the City of Tumwater. Part of the contaminant migration route is beneath the Palermo residential neighborhood, and contaminated groundwater was found to be surfacing in the crawlspaces of homes in the neighborhood. PCE and TCE can volatilize from the groundwater to soil gas and enter the indoor air space.

The selected remedy includes a wellhead treatment system (using air stripping technology) at the wellfield, a soil vapor extraction (SVE) system and institutional controls at one of the source areas, a French drain in the Palermo neighborhood, and long-term groundwater monitoring.

A five-year review site inspection was conducted on July 9, 2003. The site inspection was combined with a group-discussion style interview with personnel from the City of Tumwater and the Washington State Department of Ecology. The five-year review was advertised in local papers, and fact sheets were distributed to solicit public input.

Six issues and nine recommendations were identified through the five-year review process (see the summary form that appears at the end of this executive summary).

The remedy is expected to be protective of human health and the environment upon attainment of groundwater RGs through natural attenuation and capture and treatment at the Palermo wellfield. Attainment of groundwater RGs may require decades to achieve. In the interim, most exposure pathways that could result in unacceptable risks are being controlled, and institutional controls are preventing exposure to, or ingestion of, contaminated groundwater.

The indoor-air exposure pathway may not be adequately controlled, and a determination of protectiveness for this pathway is deferred until additional assessment is performed by EPA. The additional assessment will consist of either additional sampling, additional remedial actions, or both. A plan for this additional assessment will be completed by April 30, 2004. The protectiveness determination for the indoor-air pathway will be published as an addendum to this review at the conclusion of EPA's assessment. A schedule for publication of the addendum will be developed as part of the assessment plan.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Palermo Wellfield Superfund Site		
EPA ID *(from WasteLAN):* WAD0000026534		
Region: 10	**State:** WA	**City/County:** Tumwater/Thurston
SITE STATUS		
NPL status: . Final √ Deleted √ Other (specify) _____		
Remediation status (choose all that apply): √ Under Construction . Operating √ Complete		
Multiple OUs? √ YES . NO	**Construction completion date:** 01/ 30/2001	
Has site been put into reuse? . YES √ NO		
REVIEW STATUS		
Lead agency: . EPA √ State √ Tribe √ Other Federal Agency _____		
Author name: Robert Kievit		
Author title: Work Assignment Manager	**Author affiliation:** EPA Region 10 WOO	
Review period: 03/31/1998 to 09/30/2003		
Date(s) of site inspection: 07/09/2003		
Type of review: . Post-SARA √ Pre-SARA √ NPL-Removal only √ Non-NPL Remedial Action Site √ NPL State/Tribe-lead √ Regional Discretion		
Review number: . 1 (first) √ 2 (second) √ 3 (third) √ Other (specify)		
Triggering action: . Actual RA Onsite Construction at OU #N/A √ Actual RA Start at OU#____ √ Construction Completion √ Previous Five-Year Review Report √ Other (specify) _____		
Triggering action date *(from WasteLAN):* 06/01/2000		
Due date *(five years after triggering action date):* 06/01/2005		

Five-Year Review Summary Form (Continued)

Issues:

1. Transfer of personal property, real property, and easements is not complete.
2. TCE in indoor air at one home indicates upper end of acceptable EPA risk range; RAO has not been met.
3. Deed restriction at Southgate Dry Cleaners is not implemented.
4. Low-level analysis for vinyl chloride has not yet been performed.
5. Public access to the aeration lagoon has not been adequately restricted.
6. Fish passage through the lagoon weir may not be adequate.

Recommendations and Follow-up Actions:

1. Complete personal property, real property, and easement transfers.
2. Perform additional evaluation of the indoor-air pathway.
3. Solicit public input on remedy status.
4. Implement deed restriction at Southgate Dry Cleaners.
5. Consult with Washington State Department of Fish and Wildlife regarding fish passage through lagoon.
6. Lock lagoon gate and install warning sign.
7. Evaluate and abandon unused monitoring wells.
8. Collect influent samples from wellfield wells prior to each future five-year review.
9. Consider an explanation of significant difference to update RGs during next five-year review, based on promulgation of new cancer potency factors.

Protectiveness Statement(s):

The remedy is expected to be protective of human health and the environment upon attainment of groundwater RGs through natural attenuation and capture and treatment at the Palermo Wellfield. Attainment of groundwater RGs may require decades to achieve. In the interim, most exposure pathways that could result in unacceptable risks are being controlled, and institutional controls are preventing exposure to, or ingestion of, contaminated groundwater.

The indoor-air exposure pathway may not be adequately controlled, and a determination of protectiveness for this pathway is deferred until additional assessment is performed by EPA. The additional assessment will consist of either additional sampling, additional remedial actions, or both. A plan for this additional assessment will be completed by April 30, 2004. The protectiveness determination for the indoor-air pathway will be published as an addendum to this review at the conclusion of EPA's assessment. A schedule for publication of the addendum will be developed as part of the assessment plan.

Other Comments: None.

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ABBREVIATIONS AND ACRONYMS

AF	attenuation factor
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPF	cancer potency factor
COC	chemical of concern
Ecology	Washington State Department of Ecology
E&E	Ecology and Environment, Inc.
EPA	U.S. Environmental Protection Agency
Fe	iron
FS	feasibility study
gpm	gallon per minute
HI	hazard index
IRIS	Integrated Risk Information System
J-E	Johnson-Ettinger
L/m^3	liter per cubic meter
LTM	long-term monitoring
MCL	maximum contaminant level
MTCA	Model Toxics Control Act
$\mu g/m^3$	microgram per cubic meter
µg/L	microgram per liter
mg/kg	milligram per kilogram
mg/kg-day	milligram per kilogram per day
OEHHA	Office of Environmental Health Hazard Assessment (California State)
O&M	operation and maintenance
ORD	Office of Research and Development (EPA)
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OEHHA	Office of Environmental Health Hazard Assessment (California State)
PCE	tetrachloroethene
PID	photoionization detector
QA	quality assurance
QAPP	quality assurance project plan
RAC	Response Action Contract
RAO	remedial action objective
RfD	reference dose

ABBREVIATIONS AND ACRONYMS (Continued)

RG	remediation goal
RI	remedial investigation
ROD	Record of Decision
RPD	relative percent difference
SAB	Science Advisory Board
START	Superfund Technical Assistance and Response Team
SVE	soil vapor extraction
TCE	trichloroethene
URS	URS Group, Inc.
VOC	volatile organic compound
WA	work assignment
WAC	Washington Administrative Code
WDOH	Washington State Department of Health
WDOT	Washington State Department of Transportation

1.0 INTRODUCTION

This report presents the results of the first five-year review of the Palermo Wellfield Superfund Site ("the site") in Tumwater, Washington ("the site," Figure 1-1). Figures and tables referred to in this report are provided at the end of the section in which they are first mentioned. The purpose of this five-year review is to determine whether the remedial actions implemented at the site are protective of human health and the environment. The methods, findings, and conclusions of the review are documented in this report. In addition, this report presents issues identified during the review and includes recommendations to address them.

The U.S. Environmental Protection Agency (EPA) Region 10 conducted this five-year review during the period June 2003 through September 2003. Analysis and report preparation support for this five-year review was provided to EPA Region 10 by URS Group, Inc. (URS) under EPA Response Action Contract (RAC) No. 68-W-98-228, as defined by Work Assignment (WA) No. 108-FR-FE-104K.

EPA Region 10 conducted this five-year review pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121 states:

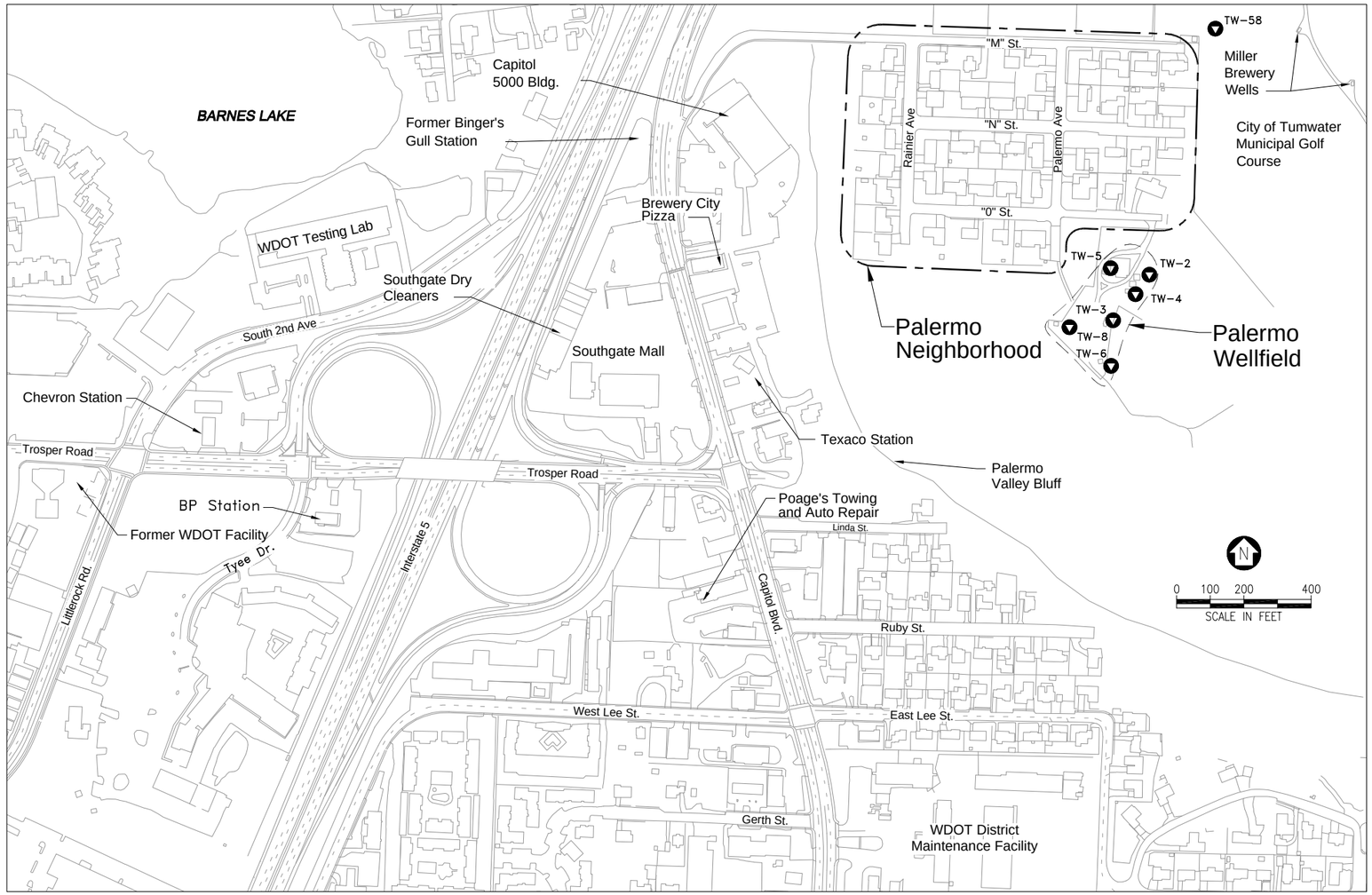
> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

EPA interpreted this requirement further in the NCP as stated in 40 CFR §300.430(f)(4)(ii):

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

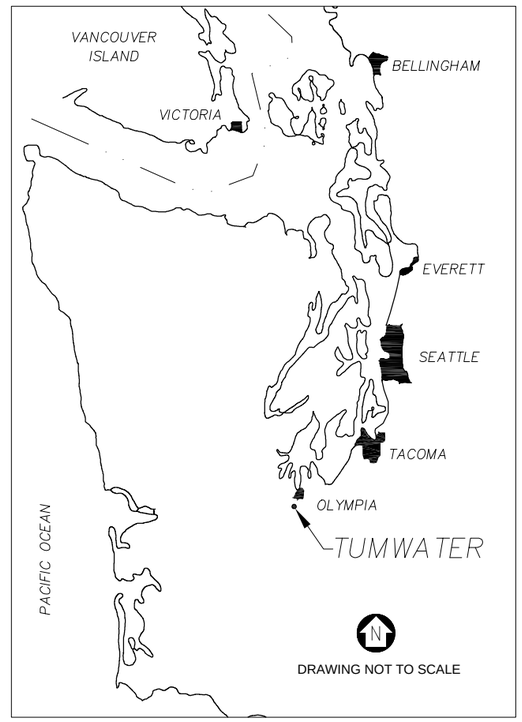
This is the first five-year review for the Palermo Wellfield Superfund Site. The triggering action for this review is the inception date of the first remedial action at the site, construction of the French drain beginning June 1, 2000. This review is being conducted early so that the

protectiveness of the indoor-air remedy can be assessed. This five-year review is required because the hazardous substances tetrachloroethene (PCE) and trichloroethene (TCE) remain present at the site above the remediation goal (RG) concentrations selected in the Record of Decision (ROD [USEPA 1999a]), preventing unlimited use and unrestricted exposure.



PALERMO NEIGHBORHOOD BOUNDARY

APPROXIMATE AREA OF PALERMO WELLFIELD SUPERFUND SITE



VICINITY MAP

Figure 1-1
Site Location Map

EPA REGION 10

108-FR-FE-104K
Palermo Wellfield Superfund Site
FIVE-YEAR REVIEW

FILENAME: T:\RAC\Palermo\Sub-Tasks\5 YR REVIEW\FIG 1-1 SITE LOC.dwg
EDIT DATE: 12/10/03 AT: 14:45

2.0 SITE CHRONOLOGY

The chronology of key site events is summarized in Table 2-1. The impetus for initial action at the site was the detection of TCE in routine water samples collected in 1993 from the City of Tumwater's municipal wellfield (named the Palermo Wellfield), at a concentration exceeding the federal maximum contaminant level (MCL). Later in 1993, investigations by the City of Tumwater and the Washington State Department of Ecology (Ecology) identified one source area as Southgate Dry Cleaners where PCE was being disposed of in a drywell. Subsequent investigations delimited a plume of both TCE and PCE in groundwater, emanating from multiple sources upgradient of the Palermo Wellfield.

The site was added to the National Priorities List (NPL) on April 1, 1997. Initial removal actions included installation of a soil vapor extraction (SVE) system at Southgate Dry Cleaners, which began operation on March 24, 1998, and installation of a wellhead treatment system at the Palermo Wellfield, which began operation in February 1999.

The remedial investigation and feasibility study (RI/FS) were completed by June 30, 1999, and the ROD was signed on November 16, 1999. The remedy selected in the ROD included continued operation of the SVE and wellhead treatment systems and construction of a third remedy component. This third component consisted of a French drain and treatment lagoon designed to lower contaminated groundwater elevation within the Palermo residential neighborhood. The design for this component of the remedy was completed on June 9, 2000. Construction notice to proceed was issued on July 25, 2000, with construction performed between August 8, 2000, and January 9, 2001. Final construction acceptance occurred on January 30, 2001. The preliminary closeout report was signed on February 22, 2001.

Table 2-1
Chronology of Site Events

Event	Date
Initial discovery of trichloroethene exceeding the maximum contaminant level at the Palermo Wellfield	1993
Pre-National Priorities List investigations and responses	1993 to 1997
Listed on National Priorities List	April 1, 1997
Soil vapor extraction removal action at Southgate Dry Cleaners	March 24, 1998 to June 2000
Wellhead treatment removal action (construction complete)	February 1999
Remedial investigation/feasibility study complete	June 30, 1999
Record of Decision signed	November 16, 1999
French drain and treatment lagoon remedial design start	November 1999
Remedial design complete	June 9, 2000
Remedial action construction notice to proceed	July 25, 2000
Construction dates (start and finish)	August 8, 2000 to January 9, 2001
Construction acceptance date	January 30, 2001
Preliminary closeout report signed	February 22, 2001
Previous five-year reviews	None

3.0 BACKGROUND

The Palermo Wellfield Superfund Site lies within the city limits of Tumwater, in the Puget Sound Basin of western Washington (Figure 1-1). The Superfund site includes the Palermo Wellfield and the Palermo neighborhood, located within the Deschutes River Valley, and the adjacent uplands area to the west. The elevation of the uplands area is approximately 60 feet higher than the river valley. The Deschutes River Valley trends north-south, with river flow to the north-northwest toward Puget Sound.

Land use at the Palermo Wellfield Superfund Site currently consists of mixed commercial and residential development within the city limits of Tumwater. This land use is not expected to change substantially in the foreseeable future. Detailed descriptions of the physical characteristics, contaminant sources, contaminant concentrations, contaminant distribution, and cleanup alternatives evaluated for the site as a whole are included in the RI report (USEPA 1999c) and the FS report (USEPA 1999b) for the site. The RI indicated that the primary site contaminants were PCE and TCE. The sources for these contaminants are several facilities located in the uplands area, including the Southgate Dry Cleaners and two locations (one former and one current) of the Washington State Department of Transportation (WDOT) Materials Testing Laboratory (Figure 1-1). PCE and TCE were found to have migrated in the direction of groundwater flow from the uplands area to the Palermo Wellfield, where TCE was detected in the municipal water supply in 1993. The ROD (USEPA 1999a) reports an estimated volume of contaminated groundwater in the range of 53 to 196 million gallons. Receptors for this plume of contaminated groundwater included the human users of this drinking water supply. In spring 1999, the EPA began the operation of an air-stripping treatment system at the Palermo Wellfield to remove PCE and TCE contamination from the water supply. Operation of this system was turned over to the City of Tumwater (also referred to as "the City"). The FS concluded that this air-stripping system would eventually remediate the contaminated groundwater at the site.

In addition to the TCE detected at the Palermo Wellfield, shallow groundwater containing PCE and TCE was found to surface near and at the base of the Palermo bluff, ponding as surface water in the yards and crawlspaces of some of the homes in the Palermo neighborhood. Ponded water in the crawlspaces poses a risk to human health (based on theoretical calculations), because PCE and TCE volatilize from the water into the air inside homes. In 2000, EPA installed a subdrain system (sometimes referred to as the "French drain") and treatment lagoon to collect and treat this shallow groundwater. The subdrain system was installed west of the residences located along the western side of Rainier Avenue. The collected water is transported to a treatment lagoon located at the City of Tumwater Municipal Golf Course. The water is treated by surface aeration, and the treated water ultimately discharges to the Deschutes River via an existing watercourse.

The purpose of the subdrain system is to lower the groundwater table to prevent water containing volatile contaminants from collecting in the crawlspaces below the residences along Rainier Avenue. EPA operated the subdrain system during a 1-year performance validation period, transferring operation and maintenance of the system to the State of Washington in February 2002.

Although operation and maintenance of specific remedy components have been transferred from EPA to state and local agencies, EPA retains responsibility for long-term monitoring of groundwater beneath the site.

4.0 REMEDIAL ACTIONS

4.1 REMEDY SELECTION

The ROD (USEPA 1999a) established the following remedial action objectives (RAOs) for the Palermo Wellfield Superfund Site:

- Clean up aquifer.
- Prevent ingestion of, or exposure to, groundwater containing carcinogens in excess of applicable or relevant and appropriate requirements (ARARs) and total excess cancer risk greater than 10^{-4} to 10^{-6}.
- Prevent inhalation of chemical of concern (COC) vapors from surface water in residential crawlspaces at concentrations that result in a total excess cancer risk of greater than 10^{-6}.
- Prevent discharge of groundwater containing COCs to the Deschutes River at concentrations in excess of ARARs or resulting in an ecological hazard index (HI) greater than 1.
- Reduce the potential for PCE in soils under the Southgate Dry Cleaners to reach the groundwater.

The description of the selected remedy in the ROD is as follows:

1. The air-stripping system constructed by EPA will be operated and maintained by the City of Tumwater to treat contaminated groundwater at the Palermo Wellfield for distribution into the municipal drinking water system. Water will be treated to levels no greater than MCLs for TCE and PCE.

2. A French drain will be installed west of the residences located along the west side of Rainier Avenue. The French drain will be designed to lower the water table to a depth of 18 inches below the bottom of the crawlspaces under the residences along the west side of Rainier Avenue. Lowering the water table will reduce modeled indoor air concentrations of TCE and PCE to below the MTCA Method B air cleanup values of 1.46 $\mu g/m^3$ for TCE and 4.38 $\mu g/m^3$ for PCE. The drain will collect shallow groundwater and route it to the Tumwater Municipal Golf Course, where it will be treated by aeration in a lagoon. Treated water will drain through the existing stormwater ditch, eventually

discharging to the Deschutes River. The aerated lagoon will be designed to treat water such that the water in the stormwater ditch meets water quality standards for COCs prior to discharge into the Deschutes River. The water quality standards are based on National Toxics Rule standards, which are protective of human consumption of water and aquatic organisms. The standards are 0.8 and 2.7 µg/L for PCE and TCE, respectively.

3. An evaluation of the standing water in the Palermo community will be made. If standing water is found in the crawlspace under any home east of Rainier Avenue, it will be sampled and analyzed for PCE and TCE. If PCE or TCE is found in crawlspace water, the risk to residents of those houses will be assessed by the same methodology used in the RI human health risk assessment. If unacceptable risks are found, remedial action will be taken by either lowering the water table beneath the house or by venting the crawlspace. The choice between these two remedies will be made based upon cost effectiveness.

4. The SVE system at the Southgate Dry Cleaners will continue to operate until the soil cleanup goal for PCE is met. The cleanup goal is 0.0858 mg/kg and is based on the MTCA Method B soil cleanup level for the protection of groundwater. Attainment of the soil RG goal will be evaluated based on PCE concentrations in vapor discharged from the remediation system. The change in the PCE concentrations in vapor from the initial concentration to the most recent concentration will be used to establish the present PCE concentration in soil based on the initial PCE concentration in soil. When compliance is determined, the SVE system will be shut down and removed from the site, and the extraction wells will be abandoned in accordance with ARARs. Soil samples will be collected to confirm that soil RGs have been attained. If these confirmatory soil samples indicate that RGs have not been attained at the time of system shutdown, a deed restriction will be put in place on the Southgate Dry Cleaners property to reduce the transfer of contaminants from soil to groundwater.

5. A long-term groundwater monitoring system will be developed using existing wells. Wells that are not needed for the long-term monitoring program will be abandoned in accordance with ARARs. Groundwater monitoring will then track the contaminant plume until levels of TCE and PCE are consistently less than their MCLs throughout the aquifer at the site. Groundwater samples will be analyzed for PCE, TCE, and its breakdown products.

6. A sampling program will be developed and implemented to determine the effectiveness of the French drain system. This program will focus on monitoring depth to groundwater to demonstrate that a minimum 18-inch depth of dewatering is maintained.

7. A monitoring system will be developed and implemented for the discharge from the aerated lagoon. The monitoring will confirm that the water in the lagoon meets water quality standards prior to discharge to the Deschutes River.

8. Notification will be provided to property owners, well drillers, and local officials regarding the specific location of the groundwater contaminant plume. The notification will advise that the groundwater in this area is not safe for domestic use without treatment. In the FS report, the mechanism for prevention of the use of contaminated groundwater was anticipated to be a City ordinance. Because this mechanism would be difficult to implement, and because there is very little incentive for individuals to drill new domestic wells in this fully developed area, public education was selected as a more appropriate mechanism.

4.2 REMEDY IMPLEMENTATION

This section discusses the implementation of the remedy, by component. The remedy components are discussed according to the numbering in Section 4.1.

4.2.1 Component 1—Wellhead Treatment Air Strippers

The components of the wellhead treatment system include two air-stripper towers with associated blowers, an underground clearwell, pumps, and piping. A disinfection system was also installed for future use. The treatment system was designed to address multiple objectives, but primarily to remove TCE contamination in the water from wells TW-2, TW-4, and TW-5. The air-stripper towers facilitate contaminant removal by maximizing the surface area of water exposed to the air which, in turn, enhances the release of volatile organic compounds (VOCs), including TCE, into the air. The towers were sized to accommodate levels of contamination greater than existing concentrations. The TCE concentration goal for treated water was less than 5 µg/L, which is the state and federal drinking water MCL for TCE. The City reports that TCE has not been detected in any of the treated water samples collected to date. During the design, it was estimated that 27 pounds of TCE would be emitted into the atmosphere per year. This estimate falls within the small-quantity-generator threshold of 50 pounds per year. Such generators are tasked with using the best technology available–in this case, stacks constructed on top of the air-stripper towers–to minimize the impacts of pollutant release to the air.

The six wells that supply water to the city were divided into two groups during the design, and the air-stripper tower inlet piping was configured to facilitate separation of these groups for treatment. This allowed the uncontaminated wells TW-3, TW-6, and TW-8 to be routed through an air-stripper tower to reduce the carbon dioxide in the water, thereby increasing the pH levels,

and to protect against any future contamination of these wells. The contaminated wells, TW-2, TW-4, and TW-5, can be routed to either or both of the air-stripper towers.

After the water passes through the air-stripper towers, it flows to the underground clearwell, unless overflow or a valve forces water to the overflow sump. In the latter case, the sump discharges to the stormwater system.

The blowers that supply air to the air-stripper towers are housed in the treatment building. A room within that building contains associated duct work, filters, fans, and motors. The design criteria for the blower system included the requirement that the noise level at 100 feet from the system be no greater than 45 decibels. To accomplish this, acoustical panels encompass the blower inlet. Silencers were installed upstream and downstream of the blowers. In addition, Washington State Department of Health (WDOH) required that the air-stripper tower stacks exhaust with enough force to preclude the entrance of particulates and that idle stacks were covered.

A hypochlorite disinfection system capable of injecting a solution into the piping between the air-stripper towers and the clearwell was also installed, should future regulations and/or conditions require it. During start-up, it was used to disinfect many of the treatment system components.

The clearwell is a tank 16 by 18 by 9 feet deep with four vertical-shaft turbine pumps that send water either to the distribution system or back to the clearwell through a bypass pipe. The pumps can draw as little as 50 gallon per minute (gpm) or as much as 2,000 gpm.

The wellhead treatment system is governed by a combination of manual and automatic controls. The initial configurations (i.e., which group of wells goes to which tower) is determined by opening or closing manual valves. Various conditions, such as blower air pressure and water levels in the towers and clearwell, are monitored by the instruments. Logic programming specific to the site recognizes alarm and shut-down conditions and relays the appropriate information to read-out displays, to appurtenances that can shut down the system, or to both.

With installation of this treatment system, the City of Tumwater regained full use of its groundwater wells at the Palermo Wellfield. The operation of the system is semiautomated, and the system can be monitored through a remote control unit. In anticipation of future conditions and regulations, the system design included the means to provide treatment of higher VOC concentrations than have been detected at the wellfield so far.

The wellhead treatment system began operation in February 1999. This remedy component was constructed as part of a removal action in advance of the ROD and was incorporated as part of

the selected remedy. The wellhead treatment system was constructed during the time period February 1998 through February 1999, when the system was substantially complete. Testing and optimization of the treatment system's effectiveness occurred between January and June 1999. Operation and maintenance (O&M) of this system was transferred to the City of Tumwater in April 1999. The formal transfer of personal and real property for this system has not yet been completed. As reported by the City, operation of this system has been without significant incident. The system effectively treats influent water to below the laboratory reporting limits for PCE and TCE (well below the MCLs for these constituents).

4.2.2 Component 2—French Drain and Treatment Lagoon

The French drain and treatment lagoon portion of the remedy was constructed between August 8, 2000, and January 9, 2001. The costs of designing and installing this system were higher than estimated in the ROD, because of the need to construct a pipeline beneath M Street (rather than tying into the existing stormdrain pipe) and difficult construction conditions behind the Rainier Avenue homes. Design data also revealed that a deeper, longer drain located closer to the homes would be required to meet the project objectives, which increased the design and construction costs over the ROD estimate.

Once the French drain and treatment lagoon system was constructed, EPA performed a 1-year performance validation from February 2001 through January 2002. The ROD goal for the French drain performance was to lower the groundwater elevation to 18 inches below the crawlspace floor for the homes west of Rainier Avenue. The floors of these crawlspaces were conservatively estimated to be 18 inches below ground surface. The performance goal is therefore often described as "3 feet below ground surface." The conclusions of the final status report for the performance validation period (USEPA 2002a) included the following key statements:

- Overall, the subdrain system and treatment lagoon component of the selected remedy is effective and has successfully reduced the risk to homeowners within the Palermo neighborhood to an acceptable level.

- The groundwater elevation reduction meets the performance criterion for all targeted residences (those along the west side of Rainier Avenue) except for 5101 and 5103 Rainier Avenue. Other portions of the Palermo neighborhood experience groundwater elevations within 3 feet of ground surface after some high precipitation events during the wet season.

- Based on the measured concentrations of TCE and PCE in the indoor air of Palermo neighborhood residences, COC concentrations in indoor air are either

below the MTCA Method B cleanup levels, or represent an acceptable excess cancer risk between 1 x 10^{-6} and 1 x 10^{-7}, even for 5101 and 5103 Rainier Avenue.

Following construction and performance validation of the French drain and treatment lagoon component of the remedy, Ecology agreed to perform operation and maintenance of these facilities on a temporary basis. Ecology then transferred some O&M responsibilities to the City of Tumwater. The City assumed ownership and physical maintenance responsibility for the property easements, equipment, and structures that make up the system. Ecology assumed responsibility for water quality sampling and measurement of parameters such as groundwater depths and water flow rate that demonstrate the performance of the system and its protectiveness of human health and the environment. As of this first five-year review, the formal transfer of personal property, real property, and easements from EPA to the City was not yet complete.

4.2.3 Component 3—Standing-Water Evaluation

The presence or absence of standing water in residential crawlspaces within the Palermo neighborhood was evaluated as part of the French drain design investigations. Water that was found was sampled, and the conclusions drawn from this assessment were used during design of the French drain. The design concluded that only the homes along the west side of Rainier Avenue currently required drainage, but that the conveyance piping beneath Rainier Avenue and M Street should be oversized to allow future expansion of the drain system, if necessary. The French drain designed was expected to have some influence beneath homes along the east side of Rainier Avenue, with a decreasing influence farther east.

4.2.4 Component 4—Soil Vapor Extraction System at Southgate Dry Cleaners

The SVE system was constructed and tested between November 1997 and March 1998. The treatment components of the system were located adjacent to the Southgate Mall building that contains Southgate Dry Cleaners, with piping to four extraction wells in the parking lot and one well within Southgate Dry Cleaners. The piping to the wells was underground except for the pipe to the well inside the building, which entered through the roof.

The piping from the wells was plumbed to a manifold that provided valving and sample ports to allow control and sampling of the vapor flow from each well. After the manifold, the combined vapor flow entered the extraction blower, which created the vacuum to pull vapors from the soil. After passing through the blower, the vapor entered a moisture knock-out canister to remove water prior to treatment of the vapor using a series of granular carbon filters. The treated vapor was discharged to the atmosphere through a 20-foot-tall emission stack. Water removed by the knock-out canister was periodically pumped to a temporary storage tank. Most of the treatment

components of the system were housed within a shipping container placed next to the building. The carbon canisters and the temporary water storage tank were located outside the container within a fenced compound.

The SVE system was operated from March 1998 though June 2000. In the preliminary closeout report (USEPA 2001a) the following was reported regarding the implementation of the SVE system:

> The SVE system began operation on March 24, 1998, and removed approximately 425 pounds of PCE before it was decommissioned in June 2000, based on comparing the results of vapor samples collected from the system at startup to those collected just prior to decommissioning. The highest concentration of PCE in soil beneath Southgate Dry Cleaners prior to remediation was 63.2 mg/kg. By applying the ratio of the PCE concentration in vapor samples at startup and just prior to decommissioning to the concentration in soils prior to remediation, an average PCE concentration remaining in soil within the area of SVE system influence is estimated at 0.013 mg/kg. This is below the soil remediation goal (RG) of 0.0858 mg/kg. However, the one confirmation soil sample collected in the same area following decommissioning of the SVE system indicated a concentration of 0.232 mg/kg PCE. This indicates the presence of isolated areas of soil beneath Southgate Dry Cleaners containing PCE concentrations still in excess of the RG and therefore requires a deed restriction on the property in accordance with the ROD.

At the time of preparation of this five-year review report, the deed restriction required by the ROD is not yet in place.

4.2.5 Component 5—Long-Term Groundwater Monitoring

A long-term groundwater monitoring program was initiated in 2001, with the first sampling event conducted in August 2001. The results of the August 2001, February 2002, and August 2002 sampling events were reported in the first annual monitoring report (USEPA 2003). Sampling was also conducted in April 2003; however, the results are not due to be formally reported until fall of 2003.

4.2.6 Components 6 and 7—Monitoring of French Drain and Lagoon Performance

At the completion of the performance validation period in January 2002, O&M of the French drain and treatment lagoon were initiated by Ecology and the City of Tumwater. O&M procedures and schedules were documented in an O&M manual prepared by EPA and dated August 30, 2003. During preparation of this five-year review report, Ecology has conducted two

O&M sampling events but has not yet formally reported the data. The City had conducted ongoing O&M of the physical components of the treatment lagoon aerators.

4.2.7 Component 8—Public Notice of Contaminated Groundwater

EPA published a fact sheet in February 2001, which was sent to local well drillers and property owners. The fact sheet included an alert to not drill new wells in the area of contaminated groundwater. A figure was included to show the area of contamination. In addition to this public notice, the City of Tumwater requires that all properties within the city limits be connected to the City water supply. This requirement is a disincentive to the drilling of new private wells.

4.3 SYSTEMS OPERATION AND MAINTENANCE

This section describes the O&M requirements for the remedy components, summarizes the O&M activities that have been conducted so far, and describes any problems that have been identified through O&M. Components 1, 2, and 4 through 7 of the remedy involve either ongoing O&M or periodic monitoring. The Southgate Dry Cleaners deed restriction (part of component 4) and the public notice of groundwater contamination (component 8) do not specifically require ongoing O&M or monitoring, but are reviewed for effectiveness during each five-year review. The standing-water evaluation (remedy component 3) was a one-time event conducted during predesign data collection for the French drain and treatment lagoon and does not require any O&M or monitoring.

4.3.1 Component 1—Wellhead Treatment

O&M and monitoring of the wellhead treatment air strippers is conducted by the City. O&M includes periodic change-outs of the air filters, equipment lubrication and cleaning, and equipment repair or replacement, as needed. Because no bacterial growth has been observed in the air strippers to date, no disinfection of the stripper system has been needed since the initial cleaning during startup. Monitoring consists of periodic sampling of the water discharged from the clearwell to the distribution system.

Water pumped by the six wellfield wells was initially sampled both prior to and following treatment to demonstrate treatment system effectiveness; however, sampling prior to treatment has been discontinued. During the period of air stripper construction, testing, and startup, the City collected 4 to 6 samples per well from each of the Palermo Wellfield production wells (Wells 2, 3, 4, 5, 6, and 8). Samples were collected and analyzed for VOCs in February, June, August, and September 1998 and February 1999. TCE was detected in all four samples collected from Well 2, at concentrations ranging from 1.8 to 60.2 µg/L. TCE was detected in three of the

four samples collected from Well 5, at concentrations ranging from 1.3 to 2.2 µg/L. One of samples collected from each of Wells 3 and 4 contained TCE, both at concentrations of 2.5 µg/L. TCE was not detected in any of the samples collected from Wells 6 and 8. No VOCs other than TCE were detected in any of the samples. No VOCs have been detected in samples of water treated by the air stripper system.

Air discharge monitoring is not required. Some operational difficulties have arisen since system installation and have been addressed by the City. These issues included the need to add a refrigerant air dryer system to the air supply for the pneumatically-actuated failsafe valves, troubleshooting and reprogramming of the control system, and replacement of the original air compressor.

The wellhead treatment system captures and treats hundreds of millions of gallons of water per year. For example, the City reports pumping of more than 430 million gallons of water in 2002. The City data for 2002 also indicates that pumping from the wellfield occurred during every month of 2002, in spite of the fact that the Palermo Wellfield is not the only source of water for the City.

The wellfield pumps turn on automatically when the City's reservoir drops to a specified water level. The pumps in Wells 2, 4, and 5 turn on first (at a higher reservoir level). The pumps in Wells 3, 6, and 8 only turn on if the reservoir level drops lower. When turned on, the well pumps pump at their design maximum flow rate.

4.3.2 Components 2, 6, and 7—French Drain and Treatment Lagoon Operation

Monitoring of the French drain and treatment lagoon is conducted by Ecology. Two sampling events have been conducted since completion of the performance validation period in January 2002. The report covering these events had not been published at the time of this review; however, Ecology personnel indicate that the data are consistent with those collected during the performance validation period. The concentrations of COCs in some effluent samples from the treatment lagoon have exceeded the RG; however, samples have not been collected directly from the point of compliance (the point of discharge to the Deschutes River located a significant distance downstream of the lagoon).

O&M of the physical components of the French drain and treatment lagoon is performed by the City. O&M conducted since completion of the performance validation period in January 2002 has consisted of periodic inspections of the lagoon aerators, and repair or replacement of the aerators as needed.

The only difficulty that has arisen during O&M and monitoring is keeping all three lagoon aerators running continuously. The aerators experience periodic failures, apparently as the result of suspended solids in the lagoon water which damage the motors. There are often only two of three aerators running in the lagoon.

4.3.3 Component 4—SVE System O&M

The SVE system was installed in March 1998 under the supervision of EPA's Superfund Technical Assistance and Response Team (START) contractor, Ecology and Environment, Inc. (E&E). E&E operated, maintained, and monitored the SVE system from the time of its installation until July 1999, when O&M of the system was transferred to EPA's RAC program. Under RAC, URS operated, maintained, and monitored the SVE system from July 1999 through June 2000, when the SVE system was decommissioned. Following decommissioning, confirmation soil samples were collected to evaluate the remaining PCE concentrations in soil.

O&M of the SVE system generally consisted of servicing the extraction blower, periodic vapor-phase carbon regeneration, and management of groundwater extracted together with the vapor and separated prior to air-stream treatment by the vapor-phase carbon. Monitoring of the system initially included both automatic analysis of the vapor stream, using in-line photoionization detectors (PIDs) and periodic collection of discrete vapor samples. Automatic, in-line PID monitoring was discontinued early in the project when concentrations dropped below the detection limit of the instruments, and monitoring was limited to periodic collection of discrete vapor samples. Periodic measurements of air flow rates through the system were also made throughout the operational life of the system.

As the result of various mechanical and electrical faults, the SVE system did not run continuously between March 1998 and June 2000. Although more SVE system downtime occurred than originally anticipated, this did not prevent meeting the goals for the SVE system as described in the ROD (see Section 4.1). In fact, SVE system effectiveness at similar sites is often enhanced by cyclical operation of the system.

Based on the results of the May 16, 2000, vapor sample collected from the SVE system, calculations were performed to estimate the following:

- Total mass of PCE removed by the SVE system from startup through the date of decommissioning
- Average concentrations of PCE remaining in soil below Southgate Dry Cleaners

The calculations showed that approximately 425 pounds of PCE were removed by the SVE system from March 24, 1998, through June 20, 2000. The average PCE concentration in soil within the area of SVE system influence was estimated at 0.013 mg/kg. The RG for soil in this area is 0.0858 mg/kg (USEPA 2000).

As envisioned by the ROD, the SVE system was decommissioned based on the estimated residual PCE concentration in soil calculated using the vapor concentrations. Following decommissioning, a confirmation soil sample was collected. This soil sample showed that PCE remained in soil above the RG, with a measured residual concentration of 0.232 mg/kg. This concentration is substantially lower than the PCE concentration in soil prior to SVE system operation (63.2 mg/kg), indicating that the system did remove a substantial PCE mass. However, the confirmation soil sample showed that, at least in some locations, PCE remains in soil at concentrations exceeding the RG. This condition triggers the ROD requirement for a deed restriction at Southgate Dry Cleaners.

4.3.4 Component 5—Long-Term Groundwater Monitoring

The long-term groundwater monitoring program includes semiannual sampling of 12 monitoring wells located roughly along the centerline of the PCE and TCE groundwater plume. Wells located upgradient and downgradient of the plume are included to allow assessment of changes in the areal extent of the plume. These wells are sampled semiannually, with one sampling event in the dry season and one in the wet season. During the first three sampling events (August 2001, February 2002, and August 2003), groundwater samples were analyzed for VOCs and conventional chemistry parameters to assess both changes in PCE and TCE concentrations and the likelihood of biodegradation occurring at the site. Based on these initial three sampling events, the following conclusions were drawn:

- The groundwater-flow pattern and contaminant distribution are similar to those identified during the RI. PCE and TCE concentrations remain above the RGs for these contaminants. PCE and TCE were not detected at the downgradient sentinel well (MW-110) during any of the three sampling events.

- PCE concentrations are lower than those measured during the RI and exhibit a weak seasonality. Comparison of the long-term monitoring data to the RI data implies that the removal of residual PCE in soil by the SVE system operated from March 1998 to June 2000 has resulted in decreased PCE concentrations in groundwater downgradient of Southgate Dry Cleaners.

- TCE concentrations appear slightly lower overall (compared to the RI data) in the upgradient and central portions of the plume and are similar to those found during the RI in the downgradient portion.

- There is little evidence for the occurrence of substantial biodegradation of PCE and TCE during either the wet or dry season. Conditions remain generally unfavorable for biodegradation, as found during the RI.

5.0 PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

Because this is the first five-year review, this section of the standard outline for five-year review reports is not applicable. During the next five-year review, progress made on issues identified by this first five-year review will be discussed in this section.

6.0 FIVE-YEAR REVIEW PROCESS

This section is a description of the process and findings of this first five-year review. The following parties were identified as being potentially interested in the five-year review process:

- The residents and business owners located within or near the geographic boundaries of the Palermo Wellfield Superfund Site
- The City of Tumwater
- The Washington State Department of Ecology
- The Washington State Department of Health (WDOH)

The review team selected to conduct the five-year review included personnel from EPA's RAC contractor (URS), encompassing the specialties of risk assessment, ARARs compliance, and hydrogeology. EPA personnel selected for the review team included the Work Assignment Manager, who oversaw much of the remedy implementation, and risk assessment specialists. Representatives of Ecology, WDOH, and the City were invited to provide input to the five-year review, and the review was advertised to the local community.

Because the review team quickly identified the issue of recent revisions in PCE and TCE carcinogenic potency factors that could affect the remedy protectiveness, especially through the pathway of indoor air, risk assessment specialists played a key role in the review. The review was initiated by a kickoff meeting held on June 9, 2003, which included risk assessment specialists from EPA, Ecology, WDOH, and URS. A key topic of that meeting was the risk posed by PCE and TCE in indoor air.

Following the kickoff meeting, document and data review was conducted (see Table 6-1), and revisions to the existing risk assessment were developed. A site inspection and in-person interviews (in a group meeting format) with Ecology and City personnel were conducted on July 9, 2003.

The findings of the five-year review process are discussed in Sections 6.1 through 6.4.

6.1 KEY DATA TRENDS

The key data trends for the Palermo Wellfield remedy include the following:

- PCE and TCE concentrations in municipal drinking water supplied from the Palermo Wellfield: These concentrations have been below laboratory reporting limits since installation of the wellhead treatment system.

- PCE and TCE concentrations in water discharged from the treatment lagoon: These concentrations have been above the RGs in some samples, however, concentrations at the point of compliance were extrapolated to be below the RG.

- PCE and TCE concentrations in indoor air within residences of the Palermo neighborhood: Indoor air sampling conducted during the performance validation period indicates that TCE concentrations in indoor air at one household exceeds the RG.

- PCE and TCE concentrations in groundwater throughout the aquifer: COC concentrations appear to be declining slowly, although conditions for substantial biodegradation remain unfavorable.

6.2 SUMMARY OF SITE INSPECTION

The site inspection checklist is included in Appendix A. The site inspection was conducted following the interview meeting (on July 9, 2003) (see Section 6.3). Attendees included the following:

- Bob Kievit, EPA
- Martha Maggi, Ecology
- Pam Marti, Ecology
- Kathy Callison, City of Tumwater
- Steve Craig, City of Tumwater
- Michael Meyer, URS

Not all attendees were present for the entire site inspection.

The site inspection included visits to the wellhead treatment system, the treatment lagoon at the golf course, and Southgate Dry Cleaners. Key observations made during the site inspection are discussed in the following sections.

6.2.1 Wellhead Treatment System

The O&M manual, maintenance log, and sampling results log for the wellhead treatment system are all computerized and are kept at the City Public Works office and not at the wellfield. The City files also contain hard copies of the manufacturer's literature for components of the system and the as-built drawings. No air discharge permit was required for operation of the system.

As O&M tasks are required, the computerized O&M tracking system generates work orders that are carried out by the City Public Works staff. The results of the work orders are then entered into the computerized maintenance log. Results of sampling are entered into a computerized database.

During the site inspection, the wellhead treatment system was found to be in excellent condition, well kept and clean. The ownership transfer of the wellhead treatment system personal and real property had not been completed at the time of the site inspection, but is expected to be complete by December 31, 2003.

6.2.2 Subdrain System and Treatment Lagoon

The O&M manual and associated documentation for the subdrain system and treatment lagoon is kept in hard copy by Ecology. Ecology is in the process of producing the first status report since completion of the 1-year performance validation period. This status report will document the most recent monitoring data, which Ecology personnel indicated are consistent with data collected during the performance validation period.

During the site inspection, two of the three aerators in the treatment lagoon were observed to be running. The southernmost aerator had apparently not been running for some time, as evidenced by the plants growing out of the discharge opening in the aerator float. Operating only two aerators has previously been found to be sufficient to meet discharged requirements (USEPA 2002a). Reed canary grass was observed growing on the lagoon outfall weir, probably rooted in soil lodged between the weir rocks. There was no apparent detriment to weir function because of the grass. No water was flowing through the fish access channel in the weir because of the low summer water level.

The lock for the lagoon access gate was missing and Pam Marti from Ecology mentioned that she had observed a person collecting golf balls from the lagoon area. The presence of golf balls in the lagoon does not affect the functionality of the remedy, and the balls themselves can remain in the lagoon. The lagoon area is dangerous, however, and public access should be restricted. Invasive plants have grown profusely along the banks of the lagoon, nearly overwhelming the intentional plantings, although some of the intentional plants remain. The profusion of invasive

plants makes access to the banks of the lagoon and the inflow pipe difficult and dangerous. The now well-established plants are effectively preventing erosion of the lagoon banks, but may not be meeting the aesthetic goals of the golf course and the local residents.

6.2.3 Southgate Dry Cleaners

The site inspection confirmed that the SVE system has been decommissioned and removed from Southgate Dry Cleaners. The land use at Southgate Dry Cleaners has not changed. Infiltration of precipitation to the area of residual soil contamination is still minimized by the presence of buildings (Southgate Mall) and the paved parking lot.

6.3 SUMMARY OF INTERVIEWS

Interviews were conducted with personnel from the City of Tumwater and Ecology in a group discussion format on July 9, 2003, prior to the site inspection. Attendees at the discussion were those listed in Section 6.2 as attendees of the site inspection. In addition, some queries were relayed to Dave Barclift of the City of Tumwater, and his responses have been incorporated into this summary. The questions posed to the City and Ecology staff are listed in Appendix A. In addition to verbal input during the July 9 discussion, Ecology provided brief written responses to the questions via e-mail.

6.3.1 City of Tumwater Personnel

Wellhead Treatment System

Overall, the technology of the air strippers works well. Since startup of the wellhead protection system, there have been no detections of PCE and TCE in water after treatment by the system. The City has corrected some operational problems with the system since startup, which include the following:

- Pneumatic failsafe valves were not always opening upon plant startup, because of water vapor in the air line and the valves. The City installed a refrigerant air dryer on the air line to alleviate this problem. The City has also increased the inspection and cleaning frequency on these valves to once every 6 months.

- Some programming and control-system errors caused unexplained system shutdowns early in operation. The City has performed troubleshooting and reprogramming as necessary.

- The flaps at the tops of the air-stripper towers, which close when no air is flowing through the towers to protect against debris intrusion, are difficult to keep lubricated. The City is considering ways to provide better access to the bearings. In general, the City has observed no instances of birds contaminating the air-stripper towers.

- For a while, the Well 2 pump tended not to shut down on command. The City has corrected this problem. Well 2 is a low-production well and, at first, could not keep the clearwell full on its own. This has been corrected, but the system is rarely run in this configuration.

- The air-compressor tank split and the compressor had to be replaced.

The clearwell pumps work well, and, in general, the system is not too "finicky."

EPA provided manufacturer's literature on the installed components. This literature included the manufacturer's recommendations for O&M. The City generated a computerized O&M routine based on this literature and developed a monitoring schedule in cooperation with the WDOH. The computerized system generates work orders for O&M tasks and serves as a repository for the results of O&M and sample analysis.

The City performs frequent sampling of the treated water, but discontinued influent water sampling after satisfying WDOH that the system was effective. The City regularly changes the air filters on the air stream into the strippers. The City has had load testing performed on the filters to verify that the change-out frequency is sufficient. To date, the City has observed no bacterial growth in the air strippers and so has not had to disinfect the system. A hypochlorite additive system is available, but is not currently required or used. The system was used for initial disinfection prior to bringing the air strippers online.

On startup and shutdown, each well pumps untreated water to the storm drain system for 10 to 15 seconds. This discharge water is captured and treated in the treatment lagoon installed under component 2 of the remedy.

Subdrain System and Treatment Lagoon

The aerator motors continue to fail periodically. The City finds it difficult to keep more than two aerators running at a time and would like to know if two are sufficient. If so, the City proposes to keep two aerators running while the third is held in reserve or sent in for repair.

The City storm sewer department handles the lagoon and aerators. For physical repairs or help with debris in the lagoon, Ecology should contact the City storm sewer department. The aerators are checked for operation about once a week, when City personnel are at the lift station for other work.

City personnel have noticed that some of the abandoned piezometers are beginning to jack out of the ground again.

Complaints or Comments From the Public

The City has been contacted by an individual wanting to drill a well within the city limits. The City intends to deny permission. The City was contacted once by someone requesting information regarding the easements established on private property for the subdrain system.

Some residents close to the wellfield have complained about air in their water pipes. The City suspects that this phenomenon is caused by air in the clearwell pumps that enters when the water column drains from the pumps at shutoff.

The City has received no other comments, requests, or complaints regarding the remedy.

6.3.2 Ecology Personnel

Wellhead Treatment System

Ecology does not receive performance data or updates on the wellhead treatment system, but does not believe that such updates are necessary. Ecology believes that it is important to complete the administrative activities relevant to the wellhead treatment system. These activities include preparing written clarification of contingent and long-term operation of the wellhead treatment system. Ecology sees the wellhead treatment system as being part of the overall remedy for the site and believes that a contingency should be in place covering the unlikely scenario where the City discontinues use of the wellfield and ceases operation of the wellhead treatment system. In such a scenario, a provision needs to be in place for another entity to take over operation of the wellhead treatment system for the purpose of maintaining the remedy.

Ecology would also like to see written clarification of the O&M funding source after 10 years of operation of the wellhead treatment system. Under more traditional circumstances, Ecology would be required to take over O&M of the system after 10 years.

Subdrain System and Treatment Lagoon

Ecology has been conducting O&M and monitoring of the subdrain system and treatment lagoon in accordance with the O&M plan provided by EPA. Ecology collects depth-to-water measurements at the piezometers, measures the depth of the lagoon and the cleanouts, measures water flow through the system, and collects water samples for chemical analyses.

Ecology noted that two of the three aerators in the lagoon function consistently; however, the southern aerator has typically not been operating. Ecology has found that the COC concentrations in water at the lagoon outfall exceed the RGs for surface water. Ecology intends to add regular sampling at a station closer to the point of compliance (which is a substantial distance downstream of the lagoon outfall). Although Ecology believes that the subdrain has a definite impact on groundwater elevation, it is not consistently meeting the ROD goal of lowering the groundwater elevation to 3 feet below ground surface.

Ecology is not clear on whether fish passage into the lagoon is sufficient. Ecology's last communication with the Washington State Department of Fish and Wildlife resulted in the biologist's assessment that the riprap at the lagoon outfall obstructs fish passage and should be modified.

Ecology expressed concern regarding the exceedance of the indoor air TCE concentration goal for one residence in the neighborhood and suspects that there could be exceedances at other residences that were not sampled. Ecology recommended reassessment of the human health risk. Ecology believes that the risk re-assessment should include all pathways that are affected by the recent change in the cancer potency factor for TCE.

Complaints or Comments From the Public

Ecology has received no complaints or comments from the public. Ecology did receive one call from a prospective property purchaser and one from a realtor requesting information on the remediation activities.

Deed Restrictions and Long-Term Monitoring

During the ROD development process, Ecology took responsibility for the deed restriction for the Southgate Dry Cleaners property. Ecology has not yet taken action on this deed restriction. The next step is for Ecology to review the RI and FS reports to determine which parcel numbers would be affected, based on the boundaries of remaining soil contamination.

Long-term monitoring appears to be taking place as planned. Long-term monitoring since the RI has not yet included monitoring vinyl chloride at sufficiently low detection limits. Ecology believes that this monitoring should be added for the next sampling round.

6.4 SUMMARY OF COMMUNITY INVOLVEMENT

Public meetings have been held at milestones throughout the RI/FS and remediation work at the site, and fact sheets have been provided to area property owners as new information has become available. Notices of opportunities for public input have been published in local newspapers.

For this five-year review, the following public notices were distributed:

- A fact sheet was mailed to area property owners and other parties on the site mailing list in March 2003. The fact sheet described the five-year review process and provided contact information for submitting comments.

- An article on the five-year review appeared in *The Olympian* newspaper on March 26, 2003. The article included interview statements from a local resident and the City public works director, a description of the site and the five-year review process, and contact information for submitting comments.

- A retail-advertising space public announcement was published in *The Olympian* newspaper on March 4, 2003. The public announcement included a description of the five-year review process and contact information for providing comments.

Comments were received from three members of the public. The comments included a question regarding the safety of soil for the planting of vegetables, a comment on unhealthy wildlife observed in the area, and speculation regarding home sales and cancer deaths in the neighborhood. Two individuals offered suggestions for other potential sources of contamination not identified in the RI/FS.

Table 6-1
Documents Reviewed

Document Title	Summary of Contents Relevant to Five-Year Review
Final Remedial Investigation for Palermo Wellfield Superfund Site, Tumwater, Washington, June 1999	Baseline risk assessment and extensive data summaries
Final Feasibility Study for Palermo Wellfield Superfund Site, Tumwater, Washington, May 1999	Risk assessment evaluation of various remedy configurations
Final Record of Decision, Palermo Wellfield, City of Tumwater, Thurston County, Washington, October 1999	Remedy selection, description, and background; applicable or relevant and appropriate requirements and remedial action objectives and goals
Annual Monitoring Report, August 2001–August 2002, Palermo Wellfield Superfund Site, February 2003	Results of long-term groundwater monitoring, including sampling events in August 2001, February 2002, and August 2002, and comparison of results to RI data
Draft Final Operation and Maintenance Plan, Subdrain System and Treatment Lagoon, Palermo Wellfield Superfund Site, Tumwater, Washington, December 2000	Discussion and presentation of groundwater and surface water data collected during design phase of French drain and treatment lagoon
Status Report, August-October 2001, Subdrain System and Treatment Lagoon, Palermo Wellfield Superfund Site, Tumwater, Washington, November 2001	Presentation and discussion of third-quarter monitoring data for French drain and treatment lagoon, including two rounds of indoor air sampling in residences of the Palermo neighborhood
Status Report, November 2001–January 2002, Subdrain System and Treatment Lagoon, Palermo Wellfield Superfund Site, Tumwater, Washington, *Revision 1*, May 2002	Presentation and discussion of final (fourth quarter) monitoring data for performance validation of French drain and treatment lagoon
Operation and Maintenance Manual, Subdrain System and Treatment Lagoon, Palermo Wellfield Superfund Site, Tumwater, Washington, August 2002	O&M and monitoring procedures and schedule to be used by Ecology and City during O&M and monitoring of French drain and treatment lagoon
Preliminary Closeout Report, Palermo Wellfield Superfund Site, Tumwater, Washington, February 2001	Summary of remedy implementation history and identification of trigger date for first five-year review
Soil Vapor Extraction System Operation, Decommissioning, and Confirmation Soil Sampling, Palermo Wellfield Superfund Site, August 2000	Summary of soil vapor extraction system operation, decommissioning, and confirmation soil sampling under the EPA Response Action Contract program

Table 6-1 (Continued)
Documents Reviewed

Document Title	Summary of Contents Relevant to Five-Year Review
Southgate Dry Cleaners and the Palermo Well Field Removal Report, March 2000	Description of the construction, testing, and initial operation of the soil vapor extraction system at Southgate Dry Cleaners and the wellhead treatment system at the Palermo Wellfield (prepared under the EPA Superfund Technical Assistance and Response program)
Health Consultation, Evaluation of PCE and TCE in Residential Indoor Air, Palermo Well Field Ground Water Contamination, Tumwater, Thurston County, Washington, EPA Facility ID WA0000026534, April 2002.	Washington State Department of Health evaluation of health risks posed by PCE and TCE concentrations measured in indoor air during French drain and treatment lagoon performance validation period
EPA plans checkup of Palermo Superfund site, Palermo Wellfield Superfund Site, Tumwater, Washington, March 4, 2003	Newspaper publication notifying public of five-year review and providing EPA contact information for comments and questions
Feds will review cleanup of local Superfund Site, March 2003	Newspaper article in *The Olympian* summarizing current conditions at the site and notifying the public about the five-year review, including EPA contact information for comments and questions
Superfund Fact Sheet, Palermo Wellfield, Tumwater, Washington, February 2001	Public notice of contaminated groundwater

Notes:
EPA - U.S. Environmental Protection Agency
O&M - operation and maintenance
PCE - tetrachloroethene
TCE - trichloroethene

7.0 TECHNICAL ASSESSMENT

7.1 FUNCTIONALITY OF REMEDY

This section answers the question, "Is the remedy functioning as intended by the decision documents?" Each component of the remedy is discussed in the sections that follow, generally in the order that the components were described in Section 4.1. In cases where a single overall action was taken to address multiple remedy components, those components are grouped within the sections below.

7.1.1 Wellhead Treatment System

The wellhead treatment system (remedy component 1, Section 4.1) is functioning as intended by the ROD. Implementation of the system has met the intent of the ROD, and the City is consistently providing comprehensive O&M and monitoring of the system. No COCs have been detected in treated water distributed through the municipal water system. Regular pumping of the wellfield wells throughout the year ensures that the contaminant plume continues to be captured and treated. The results of long-term monitoring (Section 7.1.4) indicate that contaminants have not migrated to the downgradient monitoring well.

Future functionality of the wellhead treatment system component of the remedy could conceivably be impaired if the City substantially reduces or discontinues its use of the wellfield for municipal water production. EPA will request that the City notify both EPA and Ecology 6 months in advance of any such change. If such a notice is received EPA and Ecology will develop contingencies to allow other entities (e.g., Ecology) to continue the regular pumping and treatment of groundwater to ensure plume capture, if necessary.

7.1.2 Subdrain System and Treatment Lagoon ("French Drain")

The subdrain system and treatment lagoon is only partly functioning as envisioned by the ROD. Two of the residences west of Rainier Avenue continue to consistently experience groundwater within 3 feet of the ground surface. Some other residences also experience groundwater within 3 feet of ground surface for short periods following high precipitation events (USEPA 2002a). Indoor air in one home, located approximately 200 feet east of the drain alignment, was found to consistently exceed the ROD goal for TCE, although groundwater is rarely within 3 feet of the ground surface beneath this home. In contrast, at one of the two homes west of Rainier Avenue that consistently experiences groundwater within 3 feet of the ground surface and which is located above the highest concentrations of PCE and TCE in groundwater, PCE and TCE concentrations in indoor air were below the ROD goals. This comparison suggests that the

dewatering goal established in the ROD is not a completely reliable measure of indoor air protectiveness. This issue is discussed further in Section 7.2.2.

The subdrain system and treatment lagoon (remedy component 2, Section 4.1) was implemented in accordance with the ROD. The drain was designed to lower the water table beneath the residences along the west side of Rainier Avenue to 18 inches below the bottom of the crawlspaces (i.e. approximately 3 feet below ground surface). Modeling indicated that this reduction in water table elevation would reduce indoor air concentrations of PCE and TCE to acceptable levels.

Water collected by the installed drain is treated at an aerated lagoon at the City of Tumwater's Municipal golf course, and the treated water appears to meet the RGs prior to discharge to the Deschutes River, even without the aerators operating (USEPA 2002a). Water samples collected during the one-year performance validation period without the aerators operating demonstrated that consistent operation of only two out of three aerators is sufficient for meeting RGs (USEPA 2001a).

During design of the subdrain system, the presence of standing water in the Palermo Neighborhood crawlspaces was evaluated in accordance with remedy component 3. At the time of the design, it did not appear to be necessary to add homes to the remedy, other than those west of Rainier Avenue.

In accordance with remedy components 6 and 7 (Section 4.1), a monitoring and sampling program was implemented to document the effect of the drain on groundwater elevation and the treatment effectiveness of the aeration lagoon. The sampling program does not include periodic sampling from the point of compliance for discharge of treated water to the Deschutes River, but instead relies on the results of a one-time sampling event at the river and extrapolation of periodic sample results from the lagoon outfall.

7.1.3 Soil Vapor Extraction System at Southgate Dry Cleaners

The soil vapor extraction system at Southgate Dry Cleaners functioned in accordance with the ROD. The system was operated until PCE concentrations in extracted vapor indicated that it was likely that the soil RGs had been met. The system was then decommissioned, and confirmation soil samples were collected. These soil samples indicated that some PCE remains in soil at concentrations exceeding the RG. In accordance with the ROD, a deed restriction is required to reduce the transfer of PCE from soil to groundwater. The deed restriction is not yet in place. However, the land use at Southgate Dry Cleaners has not changed.

7.1.4 Long-Term Groundwater Monitoring

The long-term groundwater monitoring program has been implemented in accordance with remedy component 5 (Section 4.1). Samples are collected from 12 wells located throughout the COC plume. Monitoring indicates that the plume continues to be captured by the Palermo wellfield wells, that contaminant concentrations are declining slowly, and that biodegradation is not significant because of unfavorable groundwater chemistry. The abandonment of unused wells has not yet been implemented as described in the remedy, although no specific schedule was established for this task in the ROD.

7.1.5 Public Notification of Contaminated Groundwater

The public notification of contaminated groundwater has been completed and in accordance with the ROD (remedy component 8, Section 4.1). A fact sheet has been mailed directly to well drillers and property owners in the area, specifically discussing the contaminated groundwater. Property owners have also received fact sheets during the course of the investigation and remediation that provide information about all aspects of the work, including the presence of contaminated groundwater. Officials from WDOH, Ecology, and the City of Tumwater have been involved in many aspects of the RI/FS and remediation work at the site and are well informed of the presence of contaminated groundwater.

7.2 CONTINUED VALIDITY OF RECORD OF DECISION ASSUMPTIONS

This section answers the question, "Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection still valid?"

7.2.1 Changes to Applicable or Relevant and Appropriate Requirements (ARARs)

In the preamble to the final National Contingency Plan (NCP), EPA states that ARARs are generally "frozen" at the time of the ROD signature, unless a new or modified requirement calls into question the protectiveness of the selected remedy. Therefore, all the ARARs identified in the ROD were reviewed for changes that could affect the assessment of whether the remedy is protective. Based on this review, it was concluded that four of the regulations listed as ARARs could have changed. Each of these four ARARs and their associated regulations are discussed in the remainder of this section.

- Washington State primary MCLs for groundwater
- National Toxics Rule water quality standards for surface water
- MTCA cleanup standards in WAC 173-340-740 for soil
- MTCA cleanup standards in WAC 173-340-750 for air

No changes have been made to the primary MCLs or to the National Toxics Rule standards for PCE and TCE since the ROD was signed in 1999. (The National Toxics Rule standards are applicable to the discharge of surface water to the Deschutes River.)

Changes have been made to the MTCA regulations (Ch. 173-340 WAC), which are cited as the source of soil and air cleanup standards in the 1999 ROD. These MTCA changes became effective in August 2001. The amendments to the MTCA regulations did not change the formulas for calculating standard MTCA Method B cleanup levels for soil and air. However, the MTCA amendments (173-340-708[7] and [8]) changed Ecology's sources of reference doses and carcinogenic potency factors to include reference doses and cancer potency factors (CPFs) available from EPA's National Center for Environmental Assessment (NCEA) when these values are not available on EPA's Integrated Risk Information System (IRIS), an online toxicity database. An oral reference dose, an inhalation reference concentration, and a cancer slope factor applicable to both inhalation and oral exposures are newly available for TCE. The new TCE values have all been endorsed by NCEA. For PCE, the oral reference dose on IRIS has not changed, but there are now inhalation and oral cancer slope factors endorsed by NCEA, although they were developed by the California Environmental Protection Agency (USEPA 2003c). The latter are provisional values to be used until EPA's IRIS review process for PCE, currently underway, has been completed. The changes in the toxicity values for TCE and PCE would result in lower calculated Method B soil cleanup and air cleanup levels, if a remedy were selected today.

The indoor air concentrations established as ARARs in the ROD were 4.38 $\mu g/m^3$ for PCE and 1.46 $\mu g/m^3$ for TCE. These were based on the cancer potency factors then available from NCEA and the cleanup level equations in Method B, WAC 173-340-750 of the MTCA regulations, which are calculated using specific exposure assumptions and a 10^{-6} cancer risk level. While not required under MTCA, the MTCA indoor air concentration was then used to back-calculate the ROD's remediation goals for the water underlying the residences.

MTCA was also used to establish a soil cleanup level for TCE and PCE of 0.398 mg/kg and 0.0858 mg/kg. The impacted soil was present only in the upland area near Southgate Dry Cleaners.

Five-year review guidance (USEPA 2001a) indicates that the question of interest in developing the five-year review is not whether a standard identified as an ARAR in the ROD has changed in the intervening period, but whether this change to a regulation calls into question the protectiveness of the remedy. If the change in the standard would be more stringent, the next stage is to evaluate and compare the old standard and the new standard and their associated risks. This comparison is done to assess whether the currently calculated risk associated with the

standard identified in the ROD is still within EPA's acceptable excess cancer risk range of 10^{-4} to 10^{-6}. If the old standard is not considered protective, a new cleanup standard may need to be adopted after the five-year review through CERCLA's processes for modifying a remedy.

Adoption of revised RGs is not recommended at this time for soil, direct contact with groundwater, or the discharge of treated surface water, even though the carcinogenic potency factors for TCE and PCE have changed. The direct exposure pathways for soil and groundwater are incomplete as a result of the remedy, and, therefore, the protectiveness of the remedy has not changed for direct exposures to these media.

There are two exposure pathways still complete at the site: exposure to surface water in the drainage ditch behind homes at the base of the bluff in the Palermo neighborhood and exposure to indoor air due to the groundwater-to-indoor air pathway. Exposures to surface water by children playing in the ditch was not found to be a risk in the original baseline risk assessment. If the risks to children were recalculated using the new toxicity factors from NCEA, risks would still be below 1×10^{-6} for this pathway; therefore, surface water in the ditch does not need to be addressed. However, the changes to MTCA and the new recommended toxicity factors from NCEA could call into question the protectiveness of the remedy with regard to the groundwater-to-indoor air pathway. In addition, the new recommended toxicity factors from NCEA, combined with the data collected from the Palermo neighborhood in 2001, could call into question the protectiveness of the remedy through this pathway even if MTCA had not been changed. To help assess current and future protectiveness, additional risk assessment evaluation of the air pathway was undertaken during this five-year review.

7.2.2 Human Health Risk—Groundwater-to-Indoor Air Pathway

Reevaluation of the indoor-air pathway using the new cancer potency estimates for TCE and PCE, the elimination of crawlspace water in area homes by lowering the groundwater level, and refinements to the application of the Johnson-Ettinger (J-E) model spreadsheets—all changes that have occurred since the signing of the ROD—result in modifications to estimated groundwater concentrations that could result in unacceptable risks from vapor intrusion to indoor air. Based on this reevaluation, the indoor air exposure pathway may not be adequately controlled, and a determination of protectiveness for this pathway is deferred until additional assessment is performed by EPA. The additional assessment will consist of either additional sampling, additional remedial actions, or both. A plan for this additional assessment will be completed by April 30, 2004. The protectiveness determination for this indoor air pathway will be published as an addendum to this review at the conclusion of EPA's assessment. A schedule for publication of the addendum will be developed as part of the assessment plan.

The sections below describe the existing air sampling data, summarize the status of the provisional CPFs, describe the revised risks that the cleanup levels selected in the ROD represent, present potential changes to air cleanup values, and present changes to groundwater cleanup levels associated with the air cleanup level revisions. Finally, uncertainties surrounding the protectiveness of the remedy for the indoor air pathway are discussed, and recommendations for follow-on actions are made.

Indoor Air Data

In 2001, EPA offered all the homeowners within the affected Palermo neighborhood the opportunity to have their indoor air sampled. As a result, indoor air samples were collected from seven homes and crawlspaces and analyzed for PCE and TCE. Concentrations of PCE or TCE were detected in indoor air in three of the seven homes sampled. Two homes, Homes #5 and #6, had detected concentrations of PCE, and one home, Home #4, had detected concentrations of TCE. The concentrations of PCE in the living space of the two homes where PCE was detected were below the RG of 4.38 $\mu g/m^3$ established in the ROD, while the living-space concentrations of TCE slightly exceeded the ROD RG of 1.46 $\mu g/m^3$. The indoor air results for the crawlspaces and living spaces of the homes are provided on Table 7-1.

Provisional Cancer Potency Factors

The external review draft of the TCE health risk assessment (USEPA 2001b) includes a range of cancer potency factors from 0.02 to 0.4 $(mg/kg\text{-}day)^{-1}$ for both inhalation and oral exposures, based primarily on human epidemiological data, although animal data were also evaluated. EPA Region 10 and most other EPA regions recommend the use of the high end of the slope factor range, to attempt to be protective of all potential human receptors. Individuals who have increased susceptibility to the adverse effects of TCE include diabetics, people who consume ethanol or acetaminophen, people who are otherwise exposed to TCE or its metabolites, and probably children. Insufficient information was available to the authors of the TCE assessment to quantify the protectiveness of any given part of the range for sensitive individuals, so employing the high end of the range is considered prudent. EPA=s previous inhalation CPF for TCE, based on animal data of 0.006 $(mg/kg\text{-}day)^{-1}$ (USEPA 2001b), was used to calculate the air RGs presented in the ROD. The previous value has been withdrawn from EPA's IRIS toxicity database. The Science Advisory Board's (SAB's) largely favorable review of the new TCE health assessment recommended that an additional new study be evaluated and that additional clarity and transparency be incorporated into the assessment. The SAB also recognized that the data suggest that TCE may affect children differently than adults and recommended that a separate chapter be included that addresses children's exposure and susceptibility issues. EPA's Office of Research and Development (ORD) is currently working on responses to the SAB comments, and, in addition, the National Academy of Sciences will conduct a review. These

must be completed before the TCE assessment enters the formal IRIS review process. Until all of this has been completed, the Superfund Technical Support Center of NCEA has recommended the use of the external review draft of the TCE health risk assessment. EPA Region 10 toxicologists consider the external review draft TCE Health Risk Assessment to represent the best available science for evaluating risks and hazards resulting from environmental exposures to TCE.

EPA=s recommended new inhalation CPF for PCE of 0.021 $(mg/kg\text{-}day)^{-1}$ is based on a unit risk of 5.9×10^{-6} per $\mu g/m^3$, developed by California=s Office of Environmental Health Hazard Assessment (OEHHA) and is based on rodent data (OEHHA 2002). EPA is developing its own cancer evaluation of this chemical, as part of the formal IRIS review process; but there are currently no CPFs for PCE in its IRIS database or EPA-derived provisional values. However, OEHHA uses a similar process to EPA's to develop toxicity values, including peer review, and EPA toxicologists believe that the OEHHA value represents the best available science for this chemical at this time (USEPA 2003c). Therefore, EPA is recommending that the OEHHA value be used, rather than the value of 0.002 $(mg/kg\text{-}day)^{-1}$ that was used previously in the RG calculations for the ROD. This is considered a provisional value to be used until EPA completes the ongoing IRIS review process and places its own CPF into IRIS. Because the recommended inhalation cancer potency factor is endorsed by NCEA (USEPA 2003c), it is also used for current MTCA cleanup level calculations.

Potential Inhalation Risks

Because of new information affecting this site, including the new cancer potency factors for TCE and PCE, the following steps were taken:

- First, inhalation risks were calculated (using the provisional CPFs supported by NCEA) to evaluate whether the risks associated with the RGs identified in the ROD are within EPA=s acceptable risk range of 10^{-4} to 10^{-6}, established in the National Contingency Plan (USEPA 1990). If the RGs are outside the acceptable range (i.e., greater than 10^{-4}), a remedy designed to reach the RG may not be sufficiently protective.

- Second, the detected air concentrations in the homes were assessed using the new CPFs to evaluate whether there may be current risks outside EPA=s acceptable risk range. If risks are not acceptable, then the effectiveness of the remedy may require further evaluation.

- Third, a different approach to estimating indoor air concentrations from measured groundwater concentrations was taken than was used in the original feasibility

study for the site. This was done because of differences in the requirements in the application of the J-E modeling techniques and differences in site conditions from the original modeling work. The revised predicted indoor air concentrations will be used as part of a process that will be conducted in April of 2004 to determine which homes may need either more sampling and/or additional remedial action.

Using the new CPFs, the RGs established in the existing ROD represent risk levels of 1 x 10^{-5} and 7 x 10^{-5} for PCE and TCE, respectively (see Appendix B Table B-2). The ROD RGs are therefore still within EPA=s acceptable risk range.[1] However, they exceed the RAO of 1 x 10^{-6} included in the ROD and the State target goal under MTCA WAC 173-340-750 (also 1 x 10^{-6}). If air cleanup levels were to be calculated now according to the revised MTCA procedures and using the provisional CPFs, the September 2003 MTCA cleanup levels for TCE and PCE would be 0.4 µg/m^3 for PCE and 0.02 µg/m^3 for TCE, an order of magnitude reduction for PCE from the RG in the ROD and approximately two orders of magnitude reduction for TCE from the RG in the ROD (see Appendix B Table B-1). These revised MTCA air cleanup levels represent concentrations that would be protective at a 1 x 10^{-6} excess cancer risk goal.

While the ROD RGs are still within EPA's acceptable risk range, detected indoor air concentrations of TCE and PCE also need to be re-evaluated using the new CPFs to assess whether existing air concentrations result in risks above the acceptable risk range. If risks are calculated for the detected concentrations of PCE and TCE found in the three homes with detected concentrations, cancer risks for PCE are 5 x 10^{-6} and cancer risks for TCE are 1 x 10^{-4} (Appendix B Table B-2). Therefore, current air concentrations in the sampled homes are also within EPA=s target risk range and are thus potentially acceptable (although the TCE value is at the limit). The detection limit of the analytical method used for the air sample analysis is 1 µg/m^3, which is above the revised air cleanup levels. If a concentration of PCE or TCE is actually present in the home just below the detection limit, risks would be 2 x 10^{-6} and 8 x 10^{-6} for PCE and TCE, respectively. These risks are within EPA=s target risk range and are unlikely to represent a data gap that is a health concern.

Washington State Review

The state Department of Health independently reviewed the indoor air data and concluded that while the air levels posed a slight increase in cancer risk for residents, there was no public health risk (WDOH 2002).

[1] Both PCE and TCE are associated with noncancer toxic effects in addition to cancer. Noncancer toxic effects are evaluated using RfDs, rather than CPFs, and are not a concern if the hazard quotient is less than or equal to 1. The hazards at the RG concentrations are well below 1 (see Appendix B Table B-2). Note that the RfDs were revised, as well as the CPFs, since the ROD was signed. The new RfDs are provided on Table B-2 (Appendix B).

Groundwater Concentrations Protective of Indoor Air

The air RGs were also used as a target concentration goal to back-calculate to a groundwater level protective of indoor air. These groundwater levels were also included as RGs in the ROD. Because the groundwater was not expected to meet these goals for many years, the remedy selected in the ROD focused on lowering the groundwater table in the Palermo neighborhood. However, a change in the ROD's RG for indoor air and the new science and understanding of the groundwater-to-indoor-air pathway, as represented in the models now recommended by EPA, could require a change in the RG for the shallow groundwater at sometime in the future, if this pathway is still of concern. This evaluation can also be of value when considering what steps should be recommended as a result of this five-year review.

The estimation of a groundwater level protective of indoor air was calculated in the feasibility study (USEPA 1999b) using the J-E model spreadsheets currently recommended by EPA for indoor evaluations (USEPA 2002b). The groundwater RGs presented in the ROD were 0.05 µg/L and 0.27 µg/L for PCE and TCE, respectively. New groundwater cleanup levels calculated as described in this section would be 2.3 µg/L and 0.1 µg/L for PCE and TCE, respectively. These revised cleanup levels reflect changes in the J-E model (as well as in CPFs) that have occurred since the ROD was signed. The EPA has revised many of the inputs to the J-E model, based on new scientific information, and adjusted its recommendations for when the model should be used (USEPA 2002b and 2003b). Therefore, the calculation of a groundwater concentration protective of indoor air would be different from the concentration given in the ROD because of the change in EPA's J-E model spreadsheets and guidance.

The purpose of the J-E model is to estimate indoor air concentrations from groundwater concentrations under site-specific subsurface and building conditions. The model derives an attenuation factor (AF) that indicates the concentration reduction between concentrations in groundwater and indoor air. AFs were derived for PCE and TCE using the latest version of the J-E model and site-specific inputs (see Appendix B Table B-3). However, because all the homes in the Palermo neighborhood have crawlspaces and the J-E model is only designed for structures that have a floor in contact with the soil (either slab-on-grade or a basement), the AFs derived from J-E modeling may not be representative of actual attenuation at the site. Therefore, two additional methods were used to derive attenuation factors: the Farmer-Karimi model and empirical data. The estimated AFs from all three methods are presented on Table 7-2.

The baseline risk assessment for the site originally estimated air concentrations from the groundwater data using the Farmer-Karimi model, because the model could accommodate a dirt crawlspace under the homes (USEPA 1999c). The Farmer-Karimi model was originally run for the baseline conditions at the time, which included standing water in the crawlspaces of several of the homes. This model was rerun, changing some of the parameters to reflect current site

conditions (e.g., no standing water) and current understanding of the vapor intrusion pathway, resulting in a second set of attenuation factors (see Table 7-2 and Appendix B Table B-4). The AF values obtained from the Farmer-Karimi model are an order of magnitude higher than those derived from the J-E model.

Currently, EPA recommends collecting indoor air samples to evaluate the indoor air pathway whenever possible, rather than using models, because of the uncertainties surrounding model predictions (USEPA 2002b). AFs can be calculated from empirical data, if both groundwater and indoor air concentrations are available, according to the following formula (USEPA 2002b):

$$AF = \frac{Cair\ (\mu g/m^3)}{Cgw\ (\mu g/L) \times 1{,}000\ L/m^3 \times H}$$

Where:
AF = attenuation factor
Cgw = Concentration in groundwater underneath the home
Cair = Concentration in indoor air in the home
H = dimensionless Henry=s Law Constant (chemical-specific)

Site-specific AFs were derived using the detected indoor air data and estimated concentrations in groundwater beneath the homes (Appendix B Table B-5). The groundwater concentrations were estimated from isopleth maps presented as Figures 7-1 and 7-2 for PCE and TCE, respectively. The isopleths were generated using the shallowest (i.e., closest to the water table) data obtained from the piezometer sampling of 1999. The chemical concentrations closest to the water table represent the best estimate of what might be volatilizing to soil gas, since it is soil gas vapors that are reaching the homes (USEPA 2002b).

The various AFs were used with the revised MTCA air cleanup standards to estimate groundwater concentrations that may be needed at the completion of the remedy (if the pathway still exists), according to the above equation solved for groundwater concentration rather than AF (see Table 7-2 and Appendix B Table B-6). The AFs vary over two orders of magnitude with the AFs calculated using the Farmer-Karimi model, the most different. However, based on the empirical AFs, the Farmer-Karimi model is not a good predictor of actual air concentrations currently found at the site[2]. Associated groundwater cleanup levels vary by one (TCE) or two (PCE) orders of magnitude. The highest (most conservative) AFs from the empirical data are

[2]If air concentrations were to be calculated using the Farmer-Karimi model AFs for the homes with indoor air data, indoor air concentrations would be over-predicted by about an order of magnitude, because the Farmer-Karimi AFs are about an order of magnitude larger than the empirical AFs. The J-E model AFs were much more similar to the empirical values, and, therefore, the J-E model is a more accurate predictor of actual indoor air concentrations at this site.

recommended as the best values for estimating a revised groundwater cleanup level, should the RGs be revised, because the empirical values are the most representative of site conditions. The empirical AFs for TCE were all very similar values. The two PCE empirical AFs varied by an order of magnitude. The empirical PCE AF from Home #6 has a greater degree of uncertainty than the other empirical PCE AF, because the maximum groundwater concentration near this home (107 µg/L from piezometer 714) was from a depth of 8 feet and a shallower sample could not be collected. Other samples from adjacent piezometers were collected from shallower depths. Shallow concentrations at piezometer 714 could therefore be lower than indicated on Figure 7-1, and the attenuation factor would thus be higher. All AFs shown on Table 7-2 are within the range of empirical values seen at other sites. EPA=s evaluation of empirical AFs for chlorinated solvents in general found that AFs in the 10^{-4} range represent the middle (50th percentile) of the values from field test situations, although they noted that the data sets were limited (USEPA 2002b).

The range of possible groundwater concentrations calculated for TCE that correspond to a target risk of 1 x 10^{-6} for indoor air, using all estimated AFs, was 0.05 to 0.4 µg/L. The groundwater RG established in the ROD was 0.27 µg/L, which is within this range. There is more variability for the PCE range (0.6 to 12.2 µg/L); however, all potential groundwater concentrations calculated using revised AFs are higher than the ROD RG of 0.05 µg/L. Any revised evaluation should consider both carcinogenic and noncarcinogenic risks. The groundwater cleanup level for TCE in the ROD may be reviewed in the future if additional empirical data are collected that indicate an RG change for TCE might be needed.

Discussion

Using the new CPFs in risk calculations demonstrates that the air RG values in the ROD are within EPA's target risk range of 10^{-4} to 10^{-6}, as are the detected concentrations in neighborhood homes. Therefore, the RG values for air and groundwater in the ROD are still health protective, according to EPA Superfund policy, and existing home-owner risks (based on data from a small number of homes) are also within EPA's acceptable range. However, the air RGs in the ROD exceed the ROD=s RAO, which includes a target risk goal of 1 x 10^{-6}, as do the concentrations found in the homes.

Risks from TCE concentrations in air at Home #4 are at the limit of EPA's acceptable target risk range (using the new CPF) and there is uncertainty surrounding the empirical AF calculated using this home's data. For example, based on the AF calculated using Home #4 groundwater and indoor air data, TCE should have been detected at similar levels to Home #4 at both Homes #5 and #6, yet the compound was not detected at those locations. This is likely due to microvariations in subsurface soil conditions under each home and differences within each home (e.g., construction, number of windows, and possible indoor consumer sources) and makes

house-to-house predictions uncertain. A number of the homes over the highest concentration portion of the TCE plume were not sampled. If any of the microenvironments beneath those unsampled homes would result in higher TCE concentrations than at Home #4, the upper end of EPA=s target risks goal range would be exceeded and the remedy would not be considered protective. Consequently, as noted at the beginning of Section 7.2.2, EPA will be further assessing the feasibility and benefits of additional evaluation of the indoor air pathway versus, or in addition to, taking remedial actions. A plan for this assessment will be developed before April 30, 2004. Additional evaluation of the indoor air pathway may include sampling of groundwater, soil vapor, or indoor air. Additional remedial action may include improved crawlspace vapor barriers or crawlspace ventilation.

Although the concentrations of TCE and PCE do not appear to be changing much over time within the residential neighborhood, based on the consistent concentrations seen in the French drain system (February 2001 to present), the remedial action has been in place for only a short time. Concentrations in the upland source area have decreased, and, over time, these decreases will be reflected in groundwater beneath the residential neighborhood (USEPA 2003a).

The number of homes where indoor air and groundwater data collection or further remedial action may be warranted will be determined using EPA's target risk range. At the upper end of EPA's risk range, a risk goal of 10^{-4}, homes that are potentially above a groundwater concentration of 15 µg/L (Figure 7-2) may need further actions (i.e., vapor barrier or additional sampling). At the lower end of EPA's target risk range, the target risk goal stated as a remedial action objective in the ROD of 10^{-6}, homes above groundwater containing 0.1 µg/L of TCE may warrant further actions (as a practical matter, this would include all homes in the Palermo neighborhood). Details of the risk predictions from groundwater data using the highest empirical AF are presented on Appendix B Table B-2.

Indoor air concentrations of PCE are less of a concern because (1) the PCE plume is much smaller (Figure 7-1), thus fewer homes are affected, and (2) PCE is a less potent carcinogen than TCE and thus the risks, based on the existing air data, only slightly exceed a 1×10^{-6} risk level (5×10^{-6}). (Note that the PCE plume is bigger than shown on Figure 7-1, if deeper groundwater samples are considered. However, the shallow plume is the most relevant for indoor air.)

Follow-Up Actions

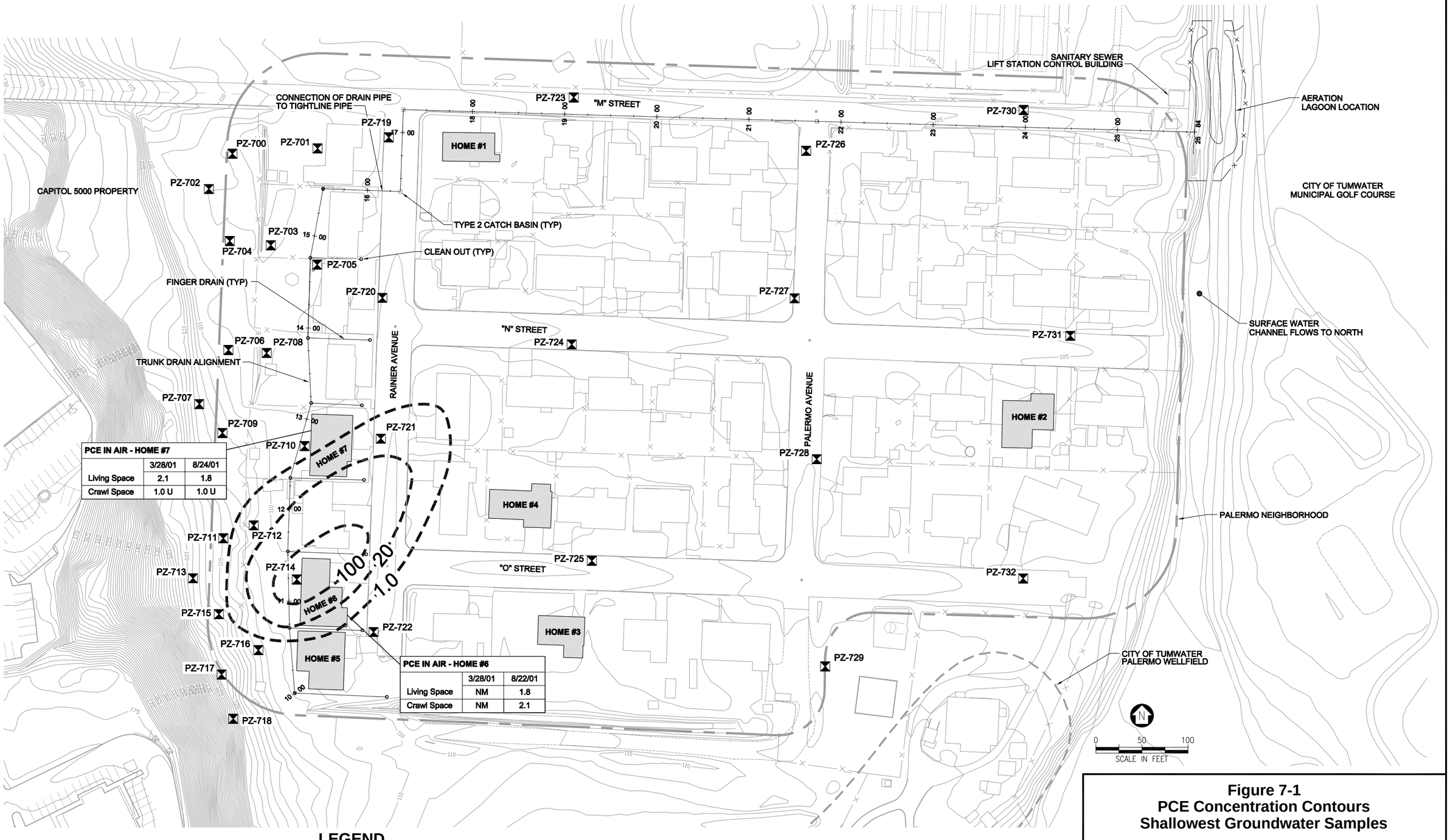
- Additional evaluation of the indoor-air pathway will be conducted.
- By April 2004, EPA will provide a plan for the additional evaluation.

- The plan will determine whether additional sampling will be conducted, whether remedial actions will be taken in the absence of additional data, or whether some combination of sampling and remedial activities is best for the site.

7.3 NEW INFORMATION

This section answers the question, "Has any other information come to light that could call into question the protectiveness of the remedy?"

Other than the information presented in the preceding sections of this report, no other new information was found during this first five-year review that would affect the protectiveness of the remedy.



PCE IN AIR - HOME #7		
	3/28/01	8/24/01
Living Space	2.1	1.8
Crawl Space	1.0 U	1.0 U

PCE IN AIR - HOME #6		
	3/28/01	8/22/01
Living Space	NM	1.8
Crawl Space	NM	2.1

LEGEND

PZ-716 Piezometer Location

PCE Tetrachloroethene

U The analyte was not detected above the reported sample detection limit.

PCE concentration contour line, values in ug/L. Based on shallowest groundwater sample at each location. Contours visually estimated.

NM Not measured

NOTES:
1. Contours based on samples collected between December 7 and 17, 1999.
2. Air samples collected from shaded homes. PCE and TCE detections in air shown in ug/m^3.

Figure 7-1
PCE Concentration Contours
Shallowest Groundwater Samples

EPA REGION 10

108-FR-FE-104K
Palermo Wellfield Superfund Site
FIVE-YEAR REVIEW

FILENAME: T:\RAC\Palermo\Sub-Tasks\5 YR REVIEW\FIG 7-1 PCE CONTOURS.dwg
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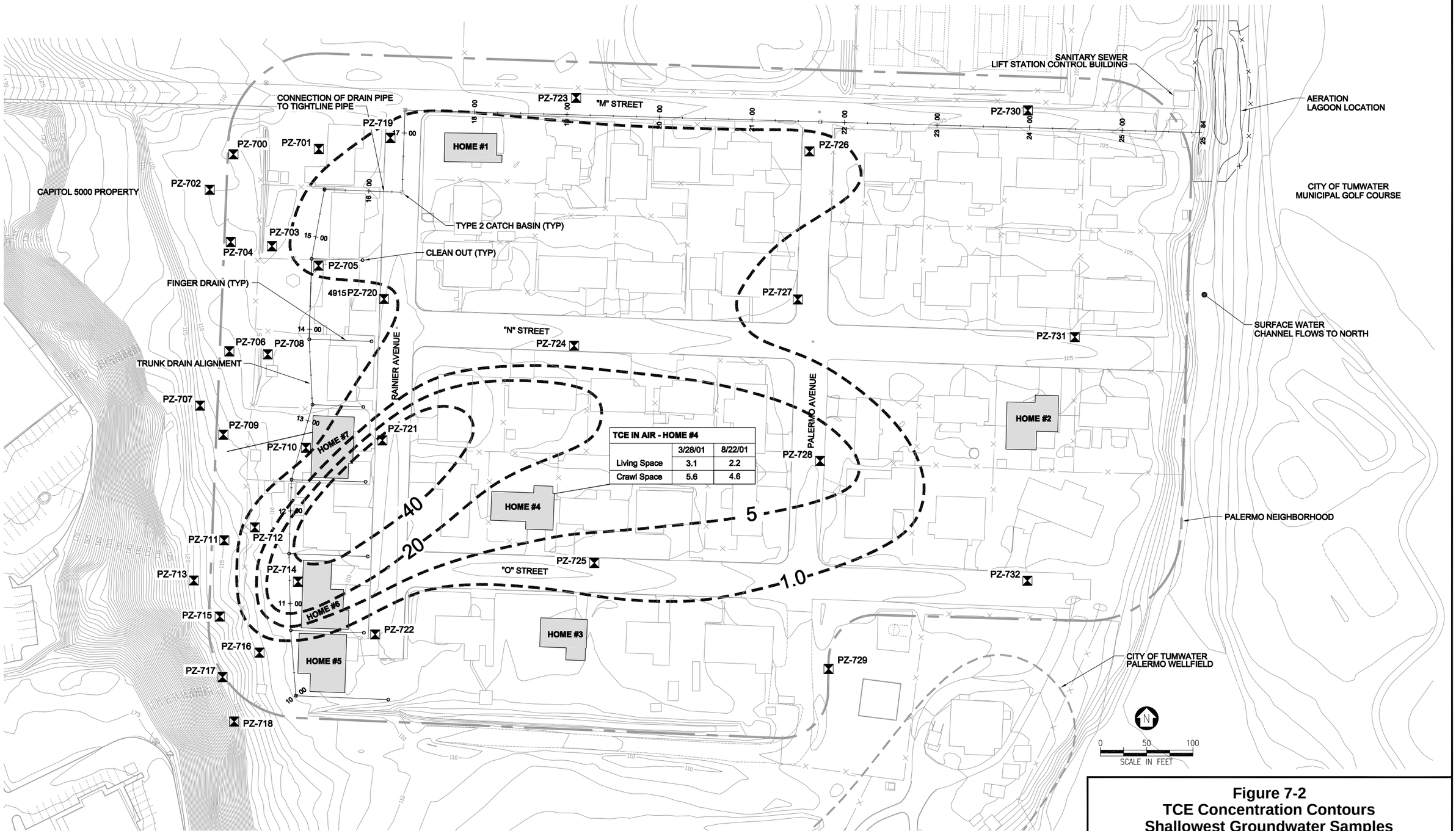

LEGEND

PZ-716 Piezometer Location

TCE Trichloroethene

U The analyte was not detected above the reported sample detection limit.

TCE concentration contour line, values in ug/L. Based on shallowest groundwater sample at each location. Contours visually estimated.

NOTES:
1. Contours based on samples collected between December 7 and 17, 1999.
2. Air samples collected from shaded homes. PCE and TCE detections in air shown in ug/m^3.

Figure 7-2
TCE Concentration Contours
Shallowest Groundwater Samples

EPA REGION 10

108-FR-FE-104K
Palermo Wellfield Superfund Site
FIVE-YEAR REVIEW

FILENAME: T:\RAC\Palermo\Sub-Tasks\5 YR REVIEW\FIG 7-2 TCE CONTOURS.dwg
EDIT DATE: 12/10/03 AT: 14:58

Table 7-1
Indoor Air Concentrations of PCE and TCE in Crawlspaces and Living Spaces

Home	Chemical	Groundwater[a] (µg/L)	Crawlspace March 2001 (µg/m^3)	Living Space March 2001 (µg/m^3)	Crawlspace August 2001 (µg/m^3)	Living Space August 2001 (µg/m^3)
Home #1	PCE	0.01U	1U	—	1U	—
	TCE	1	1U	—	1U	—
Home #2	PCE	0.01U	1U	1U	1U	1U
	TCE	0.02U	1U	1U	1U	1U
Home #3	PCE	0.01U	1U	1U	1U	1U
	TCE	0.02U	1U	1U	1U	1U
Home #4	PCE	0.01U	1U	1U	1U	1U
	TCE	15	5.6	3.1	4.6	2.2
Home #5	PCE	0.01U	—	1U	—	—
	TCE	0.02U	—	1U	—	—
Home #6	PCE	50	—	—	2.1	1.8
	TCE	20	—	—	1U	1U
Home #7	PCE	10	1U	2.1	1U	1.8
	TCE	10	1U	1U	1U	1U

[a]Groundwater concentrations were taken from Figures 7-1 and 7-2, based on shallow groundwater samples collected in 1999.

Notes:
— indicates no sample was collected
µg/m^3: microgram of chemical per cubic meter of air
µg/L: microgram of chemical per liter of water
U compound not detected at a 1 µg/m^3 detection limit

Table 7-2
Groundwater Cleanup Levels Protective of Indoor Air Using Various Attenuation Factors

Attenuation Factor Source	Attenuation Factor	Groundwater Cleanup Level (µg/L)
TCE target air concentration = 0.02 µg/m^3		
Johnson-Ettinger model	1×10^{-4}	0.4
Farmer-Karimi model	1×10^{-3}	0.05
Empirical data (5101 Rainier Ave.)	1×10^{-4}	0.4
Empirical data (5003 Rainier Ave.)	2×10^{-4}	0.2
Empirical data (206 O St.)	4×10^{-4}	0.1
PCE target air concentration = 0.44 µg/m^3		
Johnson-Ettinger model data	1×10^{-4}	4.8
Farmer-Karimi model	1×10^{-3}	0.6
Empirical data (5101 Rainier Ave.)	5×10^{-5}	12.2
Empirical data (5003 Rainier Ave.)	3×10^{-4}	2.3

Notes:
The target air concentrations shown are based on a risk goal of 1×10^{-6}.
µg/m^3 - microgram per cubic meter
µg/L - microgram per liter

8.0 ISSUES

Table 8-1 lists the issues that were identified during this first five-year review that appear to have the potential to impact the protectiveness of the remedy.

Table 8-1
Issues Identified During Review

Issue	Affects Protectiveness?	
	Current	Future
Transfer of personal property, real property, and easements is not complete.	No	No
Indoor concentrations of trichloroethene at one home are near the upper bound of U.S. Environmental Protection Agency's acceptable risk range, and the 10^{-6} risk level included in the RAO for indoor air is not being met.	No	Yes
Deed restriction at Southgate Dry Cleaners is not implemented.	No	Yes
Low-level analysis for vinyl chloride has not yet been performed.	No	Yes
Public access to the aeration lagoon has not been adequately restricted.	Yes	Yes
Fish passage through the lagoon weir may not be adequate.	No	No

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 9-1 lists the recommendations and follow-up actions for each of the issues listed in Table 8-1, together with other recommendations that do not necessarily affect the protectiveness of the remedy.

Table 9-1
Recommendations and Follow-up Actions

Recommendations/Follow-up Actions	Responsible Party	Milestone Date	Affects Protectiveness?	
			Current	Future
Personal property, real property, and easement transfers for the subdrain system, lagoon, and wellhead treatment system will be completed.	EPA	09/30/04	No	No
EPA will assess the feasibility and benefits of additional evaluation of the indoor air pathway versus, or in addition to, taking additional remedial action. A plan for this assessment will be developed before April 30, 2004. Additional evaluation of the indoor air pathway may include sampling of groundwater, soil vapor, or indoor air. Additional remedial action may include improved crawlspace vapor barriers or crawlspace ventilation.	EPA	04/30/04	No	Yes
Public input regarding the remedy status will be solicited at a public meeting.	EPA	12/15/03	No	No
The deed restriction on Southgate Dry Cleaners should be recorded to run with the deed. The restriction should require measures to reduce the migration of PCE from soil to groundwater.	Ecology	12/31/03	No	Yes
Consult with Washington State Department of Fish and Wildlife regarding fish passage through the lagoon.	EPA	07/31/04	No	No
The lagoon gate should be locked whenever O&M personnel are not on site. A warning sign should be placed on the fencing along the western side of the lagoon.	Ecology/City	12/31/03	Yes	Yes
Unused monitoring wells will be evaluated and selected wells will be abandoned.	EPA	12/31/04	No	No
Samples of the water pumped from each well in the Palermo Wellfield prior to treatment should be collected and analyzed for VOCs, including a low-level analysis for vinyl chloride, prior to each five-year review to confirm the plume configuration and air stripper loading.	City	5/31/08	No	No
Based on expected finalization of the new CPF values for PCE and TCE in the next five years, the next five-year review will consider an ESD to the ROD to update the remediation goals for all media as needed.	EPA	6/31/08	No	Yes

Table 9-1 (Continued)
Recommendations and Follow-up Actions

Notes:
City - City of Tumwater
CPF - cancer potency factor
Ecology - Washington State Department of Ecology
EPA - U.S. Environmental Protection Agency
ESD - explanation of significant difference
O&M - operation and maintenance
PCE - tetrachlorethene
ROD - Record of Decision
TCE - trichloroethene
VOCs - volatile organic compounds

10.0 PROTECTIVENESS STATEMENT

The remedy is expected to be protective of human health and the environment upon attainment of groundwater RGs, through natural attenuation and capture and treatment at the Palermo Wellfield. Attainment of groundwater RGs may require decades to achieve. In the interim, most exposure pathways that could result in unacceptable risks are being controlled and institutional controls are preventing exposure to, or the ingestion of, contaminated groundwater.

The indoor-air exposure pathway may not be adequately controlled, and a determination of protectiveness for this pathway is deferred until additional assessment is performed by EPA. The additional assessment will consist of either additional sampling, additional remedial actions, or both. A plan for this additional assessment will be completed by April 30, 2004. The protectiveness determination for the indoor-air pathway will be published as an addendum to this review at the conclusion of EPA's assessment. A schedule for publication of the addendum will be developed as part of the assessment plan.

11.0 NEXT REVIEW

The next five-year review for the Palermo Wellfield Superfund Site is scheduled to be completed 5 years from the date of this review, by September 30, 2008.

12.0 REFERENCES

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U.S. Environmental Protection Agency (USEPA). 2003a. *Annual Monitoring Report, August 2001 - August 2002, Palermo Wellfield Superfund Site, Tumwater, Washington.* Prepared by URS Group, Inc., for EPA Region 10 under RAC No. 68-W-98-228. Seattle, Washington. February 2003.

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APPENDIX A

SITE INSPECTION CHECKLIST AND INTERVIEW QUESTIONS

Site Inspection Checklist

I. SITE INFORMATION

Site name: *Palermo Wellfield Superfund Site*	**Date of inspection:** *July 9, 2003*
Location and Region: *Tumwater, WA*	**EPA ID:** *WA 0000026534*
Agency, office, or company leading the five-year review: *EPA Region 10, WOO*	**Weather/temperature:** *Sunny, 75EF*

Remedy Includes:

X Soil vapor extraction system at Southgate Dry Cleaners source area
X Wellhead treatment system at City of Tumwater Municipal Wellfield
X French drain and aeration lagoon for shallow groundwater collection and treatment
X Public notice of groundwater contamination
X Long-term monitoring of groundwater contamination
X Deed restrictions at Southgate Dry Cleaners

II. INTERVIEWS

City of Tumwater Staff

1. **City O&M manager** *Dave Barclift* (Name) *Public Works Operations Manager* (Title) *July 9,2003* (Date)
   Interviewed : at site G at office G by phone Phone no. _____
   Problems, suggestions; G Report attached _____
   See summary in five-year review report text.

2. **City O&M staff** *Steve Craig* (Name) *Public Works Water Lead* (Title) *July 9,2003* (Date)
   Interviewed : at site G at office G by phone Phone no. _____
   Problems, suggestions; G Report attached _____
   See summary in five-year review report text.

3. **Other City staff** *Kathy Callison* (Name) *Water Resources Program Mngr.* (Title) *July 9,2003* (Date)
   Interviewed : at site G at office G by phone Phone no. _____
   Problems, suggestions; G Report attached _____
   See summary in five-year review report text.

4. **Other City staff** _____ (Name) _____ (Title) _____ (Date)
   Interviewed G at site G at office G by phone Phone no. _____
   Problems, suggestions; G Report attached _____
   _____

II. INTERVIEWS, continued

Washington State Department of Ecology

5. **Ecology Project Manager** *Martha Maggi* (Name) *Site Manager* (Title) *July 9,2003* (Date)
   Interviewed : at site G at office G by phone Phone no. _____
   Problems, suggestions; G Report attached _____
   See summary in five-year review report text.

6. **Ecology O&M Staff** *Pam Marti* (Name) *Site Manager* (Title) *July 9,2003* (Date)
   Interviewed : at site G at office G by phone Phone no. _____
   Problems, suggestions; G Report attached _____
   See summary in five-year review report text.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents for Air Stripper (City of Tumwater)**

: O&M manual	: Readily available	: Up to date	G N/A
: As-built drawings	: Readily available	: Up to date	G N/A
: Maintenance logs	: Readily available	: Up to date	G N/A

Remarks *O&M manual and maintenance log are both computerized. Work orders are issued according to the maintenance schedule and then work performed is logged.*

2. **Permits for Air Stripper**

G Air discharge permit	G Readily available	G Up to date	: N/A
G Effluent discharge	G Readily available	G Up to date	: N/A
G Waste disposal, POTW	G Readily available	G Up to date	: N/A
G Other permits_____	G Readily available	G Up to date	: N/A

Remarks *The air stripping towers were modified to meet local air agency requirements. No permits were required for this system.*

3. **Discharge Compliance Records for Air Stripper**

G Air	G Readily available	G Up to date	: N/A
: Water (effluent): Readily available	: Up to date	G N/A	

Remarks *No air discharge sampling was required, and none is performed. A database is maintained of the results of water samples collected prior to distribution.*

4. **O&M Documents for French Drain and Lagoon (Ecology)**

: O&M manual	: Readily available	: Up to date	G N/A
: As-built drawings	: Readily available	: Up to date	G N/A
: Monitoring/status reports	: Readily available	: Up to date	G N/A

Remarks_____

IV. INSTITUTIONAL CONTROLS

1. **Implementation and enforcement of Southgate Dry Cleaners Deed Restriction**

Deed restriction in place? G Yes : No G N/A

Documentation of deed restriction available? G Yes : No G N/A

Type of monitoring (*e.g.*, self-reporting, drive by) *Monitoring is not required by the ROD.*

Frequency_____

Responsible party/agency_____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up-to-date

G Yes G No : N/A

Reports are verified by the lead agency G Yes G No : N/A

Specific requirements in deed or decision documents have been met G Yes : No G N/A

Violations have been reported G Yes : No G N/A

Other problems or suggestions: G Report attached

The deed restriction is not yet in place, but is in progress. Monitoring of the deed restriction is not required by the ROD.

2. **Implementation - public notice of contaminated groundwater**

Notification performed?

: Yes G No G N/A

Documentation of notification available? : Yes G No G N/A

Type of monitoring (*e.g.*, self-reporting, drive by) *Monitoring is not required by the ROD.*

Frequency_____

Responsible party/agency_____

Contact _____ _____ _____ _____

Name Title Date Phone no.

Reporting is up-to-date

G Yes G No : N/A

Reports are verified by the lead agency G Yes G No : N/A

Specific requirements in deed or decision documents have been met : Yes G No G N/A

Violations have been reported G Yes : No G N/A

Other problems or suggestions: G Report attached

EPA issue a fact sheet to area well drillers.

3. **Adequacy** : ICs are adequate G ICs are inadequate G N/A

Remarks *Although the deed restriction at Southgate Dry Cleaners has not been completed, no land use changes were observed during the site inspection, and the current land use complies with the anticipated future requirements of the deed restriction.*

IV. INSTITUTIONAL CONTROLS, continued

4 **Land use changes on site** G Changes observed : No changes observed
Remarks *The Southgate Dry Cleaner location remains a commercial property, consisting of a retail shopping center. Asphaltic concrete pavement remains throughout the parking lot and no structures have been removed.*

V. SOIL VAPOR EXTRACTION SYSTEM AT SOUTHGATE DRY CLEANERS

1. **Implementation**
: Installed and operated per ROD
: Documentation of results available

2. **Current Status**
: Status is: *Decommissioned*
: Records of current status available
Remarks *Decommissioning letter report dated August 11, 2000*

3. **Results** (summarize results of SVE system)
The SVE system removed approximately 425 pounds of PCE from soil beneath Southgate Dry Cleaners. In accordance with the ROD, the PCE concentration measured in soil vapor from the SVE system was used to estimate average residual PCE concentrations in soil. This estimate was below the RG for soil (0.0858 mg/Kg) and the SVE system was decommissioned. Confirmation soil sampling found residual PCE in soil at concentrations up to 0.232 mg/Kg at some discrete locations, indicating that institutional controls would be required per the ROD.

VI. WELLHEAD TREATMENT SYSTEM

1. **Treatment Train** (Check components that apply)
G Metals removal G Oil/water separation
: Air stripping G Carbon adsorbers
: Filters *The air used in the air strippers is filtered*
: Additive (*e.g.*, chelation agent, flocculent) *A hypochlorite additive system is available but is not required nor used.*
G Others_____
: Good condition G Needs Maintenance
: Sampling ports properly marked and functional
: Sampling/maintenance log displayed and up to date (*computerized log system)*
: Equipment properly identified
: Quantity of groundwater treated annually ~430 million gallons
Remarks *See summary in text of discussion with City personnel regarding O&M of the system.*

VI. WELLHEAD TREATMENT SYSTEM, continued	
2.	**Electrical Enclosures and Panels** (properly rated and functional) G N/A : Good condition G Needs Maintenance Remarks_____ _____
3.	**Air Stripper and Appurtenences** G N/A : Good condition G Proper secondary containment G Needs Maintenance Remarks *Secondary containment was not required for this system.*
4.	**Discharge Structure and Appurtenances** G N/A : Good condition G Needs Maintenance Remarks *Some floor drains are connected to the sanitary sewer system, while others are connected to the storm water system, depending on likely fluid to be drained.*
5.	**Treatment Building(s)** G N/A : Good condition (esp. roof and doorways) G Needs repair : Chemicals and equipment properly stored Remarks_____ _____
6.	**Real Property** Transfer from EPA to City complete? G Yes Date of transfer _____ : No Expected data of transfer *December 31, 2003* Remarks_____ _____
7.	**Results** (summarize monitoring data for Wellhead Treatment System) *Initial sampling of influent and effluent water indicated excellent performance, and influent sampling was discontinued. TCE and PCE have not been detected in any effluent (i.e. distribution water) sample collected to date.*

VII. FRENCH DRAIN AND TREATMENT LAGOON

1. **Inlet to Lagoon Pipe Inspected** : Functioning G N/A
Remarks_____
_____

2. **Inlet Pipe Riprap Rock Inspected** : Functioning G N/A
Remarks *The inlet is functioning, but is overgrown with invasive plant species, making access difficult and dangerous.*

3. **Siltation** Areal extent_____ Depth_____ G N/A
: Siltation not evident
Remarks_____
_____

4. **Erosion** Areal extent_____ Depth_____
: Erosion not evident
Remarks_____
_____

5. **Outlet Weir** : Functioning G N/A
Remarks *Reed canary grass is now growing on weir, presumably on soil lodged between weir rocks. No apparent detriment to weir function.*

6. **Aerators** G All three functioning : Less than three functioning G None functioning
Remarks *The northern aerator is no longer an aerating fountain, but a more traditional aerator. The south aerator was not functioning during the site inspection, and, based on plant growth on the aerator, has not functioned for some time.*

7. **Plantings** G Growing and healthy G Effectively reducing erosion
G Meeting aesthetic goals G Invasive weeds controlled
Remarks *The plantings around the lagoon have been mostly overwhelmed by invasive species, although some intentional plants remain. The invasive species are adequate for erosion control, but may not meet the aesthetic goals of the community and the golf course. The dense brush coverage makes movement around the lagoon difficult and dangerous.*

8. **Fencing** G Intact, gates locked : Damaged or unlocked
Remarks *The lock is missing from the access gate for the lagoon. Pam Marti of Ecology reported an incident where she observed a person accessing the lagoon to retrieve lost golf balls. The interpretive sign on the golf course side of the lagoon has been broken.*

9. **Real Property and Easements**
Transfer from EPA to City complete?
G Yes Date of transfer _____
: No Expected data of transfer *December 31, 2003*
Remarks_____
_____

VII. FRENCH DRAIN AND TREATMENT LAGOON, continued	
10.	**Results** (summarize monitoring data for French Drain and Lagoon) *Although the overall performance of the french drain and lagoon meets the expectations, the system does not meet the dewatering goal stated in the ROD for all seasons at all locations within the Palermo neighborhood. Indoor air sample data indicates that preferential flow pathways in the subsurface and/or the configuration of individual crawlspaces substantially influences the movement of PCE and TCE from shallow groundwater to indoor air. There is not a consistent correlation between PCE and TCE concentrations found in indoor air, depth to groundwater, and PCE/TCE concentrations in groundwater.*
VIII. LONG-TERM MONITORING	
1.	**Monitoring Wells** : Properly secured/locked : Functioning : Routinely sampled : Good condition : All required wells located G Needs Maintenance G N/A Remarks *Sediment accumulation resulted in the redevelopment of four monitoring wells in March 2003.*
2.	**Long-term monitoring Data** : Is routinely submitted on time : Is of acceptable quality
3.	**Long-term monitoring data suggests:** : Groundwater plume is effectively contained : Contaminant concentrations are declining G Biodegradation is occurring Remarks *There is little evidence of substantial biodegradation occurring at the site, and monitoring of biodegradation has been dropped from the long-term monitoring program. The groundwater chemistry beneath the site remains consistently unfavorable for biodegradation. Sufficient long-term monitoring data now exist to allow evaluation of the abandonment of unused monitoring wells.*
IX. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). *The remedy is intended to restore the aquifer, prevent exposure to contaminated groundwater, prevent inhalation of PCE/TCE vapors in indoor air, prevent discharge of contaminated water to the Deschutes River, and to reduce the potential for groundwater contamination from residual soil contamination beneath Southgate Dry Cleaners. The observations made during the site visit and document review indicate that overall, the remedy is effective and functioning as designed. The french drain may not be adequately reducing exposure to TCE and PCE in indoor air and further risk assessment evaluation is warranted. The institutional control remedy at Southgate Dry Cleaners is functioning, although the formal deed restriction is not yet in place.*

IX. OVERALL OBSERVATIONS, continued	
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. *Overall, the O&M being conducted is adequate to maintain remedy effectiveness. In the unlikely event that the City chooses to discontinue pumping of the wellfield wells at some future date, other O&M arrangements may be necessary to ensure plume containment. The addition of regularly scheduled surface water sampling from a station downstream of the treatment lagoon and closer to the Deschutes River would increase confidence that surface water RGs are being consistently met.*
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future. *No observations were made that were indicative of potential future remedy inadequacy to protect human health and the environment. The adequacy of the french drain system for protection of the indoor air pathway is a current issued addressed in this five-year review.*
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. *O&M of the remedy components was optimized during plan preparations, and continues to be optimized as O&M is conducted. No additional optimization opportunities were identified during this review.*

Interview Questions - City of Tumwater Staff

1. What is your overall impression of the remedy installed, including the air stripper, the drain and lagoon, and the long-term monitoring program?

2. Are the air stripper, French drain, and treatment lagoon functioning as you expected? How well are they performing?

3. Please describe the typical O&M activities and schedule performed by the City.

4. Have there been any significant changes in the O&M requirements or procedures since installation of either the air stripper or the French drain and treatment lagoon?

5. Have there been any unexpected O&M difficulties or expenses since installation of the air stripper or the French drain and treatment lagoon?

6. Do you feel sufficiently informed about the parts of the remedy that you are not directly involved in (e.g., the results of drain monitoring by Ecology and the results of long-term monitoring by EPA)?

7. Has the City received any complaints or comments from the public or other government agencies regarding any part of the remedy?

8. Do you have any comments, suggestions, or recommendations regarding the remedy?

Interview Questions - Washington State Department of Ecology Staff

1. What is your overall impression of the remedy installed, including the air stripper, the drain and lagoon, and the long-term monitoring program?

2. Is the french drain and treatment functioning as you expected? How well are they performing?

3. Please describe the typical O&M activities and schedule performed by Ecology.

4. Have there been any significant changes in the O&M requirements or procedures since installation of the french drain and treatment lagoon?

5. Have there been any unexpected O&M difficulties or expenses since installation of the french drain and treatment lagoon?

6. Has Ecology taken any action regarding deed restrictions at Southgate Dry Cleaners?

7. Do you feel sufficiently informed about the parts of the remedy that you are not directly involved in (e.g., the results of air stripper O&M by the City and the results of long-term monitoring by EPA)?

8. Has Ecology received any complaints or comments from the public or other government agencies regarding any par of the remedy?

9. Do you have any comments, suggestions, or recommendations regarding the remedy?

APPENDIX B

RISK ASSESSMENT CALCULATIONS

Table B-1
Calculation of MTCA Method B Indoor Air Cleanup Level

CAc = (CR x AT x BW x CF) / (ED x IR x CPF)		
CAnc = (RfD x ATnc x BWnc x CF x HQ) / (EDnc x IRnc)		
CR	acceptable cancer risk level (unitless)	1.00E-06
AT	averaging time (years)	75
BW	body weight (kg)	70
CF	conversion factor (ug/mg)	1000
ED	exposure duration (years)	30
IR	inhalation rate (m^3/day)	20
CPF	cancer potency factor $(mg/kg\text{-}day)^{-1}$	chemical specific TCE = 0.4 PCE = 0.021
RfD	inhalation Reference Dose (mg/kg-day)	chemical specific TCE = 0.01 PCE = 0.017
ATnc	averaging time, non-cancer (years)	6
BWnc	body weight, non-cancer (kg)	16
HQ	Hazard Quotient (unitless)	1
EDnc	exposure duration, non-cancer (years)	6
IRnc	inhalation rat, non-cancer (m^3/day)	10
CAc	indoor air concentration (ug/m^3) protective of cancer endpoint	calculated TCE = 0.02 PCE = 0.4
CAnc	indoor air concentration (ug/m^3) protective of non-cancer endpoint	calculated TCE = 16 PCE = 27

Notes:
MTCA - Model Toxics Control Act

Table B-2
Indoor Air Risks from Sample Groundwater Concentrations
(using new slope factors and highest empirical AFs)

CR = (CA x CPF x IR x ED) / (BW x AT x CF) CA = CW x 1000 L/m^3 x H x AF		
CR	cancer risk (unitless)	calculated
CA	indoor air concentration (ug/m^3)	calculated
CPF	cancer potency factor (mg/kg-day)$^{-1}$	chemical specific TCE = 0.4 PCE = 0.021
IR	inhalation rate (m^3/day)	20
ED	exposure duration (years)	30
BW	body weight (kg)	70
AT	averaging time (years)	75
CF	conversion factor (ug/mg)	1000
CW	groundwater concentration (ug/L)	site-specific
H	Henry's Constant (unitless)	chemical specific TCE = 0.422 PCE = 0.0754
AF	Attenuation factor (unitless)	chemical specific (Highest empirical AF from Table B-4) TCE = 4.19E-04 PCE = 2.52E-04

	CW (ug/L)	predicted CA (ug/m^3)	cancer risk	non-cancer hazard
TCE	0.12	0.02	1E-06	0.001
	1	0.18	8E-06	0.01
	1.6	0.28	1E-05	0.02
	5	0.88	4E-05	0.06
	8	1.46 (1)	7E-05	0.09
	10	1.77	8E-05	0.1
	15	2.65 (2)	1E-04	0.2
	20	3.53	2E-04	0.2
	30	5.30	2E-04	0.3
	40	7.07	3E-04	0.4
PCE	2.3	0.44	1E-06	0.02
		1.90 (3)	5E-06	0.07
	12.2	2.31	6E-06	0.08
		4.38 (1)	1E-05	0.2
	25	4.75	1E-05	0.2
	50	9.50	2E-05	0.3
	75	14.25	3E-05	0.5
	100	19.00	5E-05	0.7
	150	28.50	7E-05	1
	300	57.00	1E-04	2

Table B-2 (Continued)
Indoor Air Risks from Sample Groundwater Concentrations
(using new slope factors and highest empirical AFs)

Notes:
AF - Attenuation factor
J-E - Johnson and Ettinger Model for Subsurface Vapor Intrusion
CA - Chemical concentration in air
SG - Chemical concentration in soil gas
CW - Chemical concentration in groundwater

(1) These values are the RGs from the ROD, calculated using the previous recommended CPFs.

(2) This value is the average of the measured indoor air TCE concentration from Home #4, the only home with detected concentraitons of TCE in indoor air.

(3) This value is the average measured indoor air PCE concentration from Homes #6 and #7, the only homes with detected concentrations of PCE in indoor air.

Table B-3
Input Values to the Johnson and Ettinger Model for Subsurface Vapor Intrusion

Parameter	Value	Reference
GW temp	12C	Regional gw temp
Depth below grade to bottom of enclosed space floor	15 cm	Default for non-basement home
Depth to gw	110 cm	Average after french drain installation
Thickness of soil stratum A	110 cm	Same as depth to gw
Soil type	Sandy loam	URS recommendation based on grain size analysis
Effective vapor permeability	1E-8 cm2	High end for soil type, EPA J-E User's Guide, 2003
dry bulk density	1.62 g/cm3	EPA J-E User's Guide, 2003, based on soil type
total soil porosity	.387 cm3/cm3	EPA J-E User's Guide, 2003, based on soil type
Soil water-filled porosity	.07 cm3/cm3	Mid-point between low end and mean, Table 10, User's Guide, to account for drier soil underneath a building
Qsoil	not specified	Calculated by model using other inputs
Floor-wall seam gap	0.1	Default value, EPA J-E User's Guide, 2003
Building air exchange rate	.25/hr	Default value, EPA J-E User's Guide, 2003
Enclosed space floor thickness	10 cm	Default value, EPA J-E User's Guide, 2003
Enclosed space floor length	1180 cm	URS recommendation based on area-specific home sizes
Enclosed space floor width	1180 cm	URS recommendation based on area-specific home sizes
Enclosed space height	244 cm	URS recommendation based on area-specific home sizes
Resulting Attenuation Factors (AFs)	TCE = 1.3×10^{-4} PCE = 1.2×10^{-4}	model calculated values

Table B-4
Estimation of Indoor Air Concentrations from Groundwater Concentrations Using the Farmer-Karimi Model (1987)

Parameter	Units	Value PCE		Value TCE	References + Equations
Chemical Concentration in Water (CW)	ug/L	chemical specific			--
	mg/cm^3	CW x 10^{-3} mg/ug x $10^{-3}L/cm^3$			--
Soil Gas (SG)	mg/cm^3	SG = CW (in mg/cm^3) x Kh			USEPA 2002
Henry's Law Constant (Kh)	dimensionless	0.75		0.42	USEPA 2003
Air-filled porosity (n_a)	dimensionless	0.317			site-specific - from USEPA 2003 based on sandy loam soil type
Total soil porosity (n)	dimensionless	0.387			site-specific - from USEPA 2003 based on sandy loam soil type
Diffusivity in Air (Da)	cm^2/s	0.072		0.079	USEPA 2003
Diffusivity in vadose zone (Ds)	cm^2/s	0.00406		0.00445	Da x $n_a^{3.33}$ / n^2 (Karimi 1987)
Molecular Weight (MW)	g/mol	166		131	USEPA 2003
Depth from Bottom of Foundation to Water (Z)	cm	155			site-specifc (assumes crawl space height of 1.5 feet and depth to groundwater of 3.6 feet = 5.1 feet (155 cm))
Volume of Living Space / Area of Foundation (V/A)	cm	245			site-specific (volume = 340 m^3, floor area = 139 m^2)
Living Space Air Exchange Rate (ER)	s^{-1}	6.94E-05			0.25 per hour = 6.94x10^{-5} (USEPA 2003)
Surface Flux (fa) at foundation level	$mg/cm^2/s$	fa = Ds x SG / Z			Karimi 1987
Surface Flux (fa') through foundation into living space	$mg/cm^2/s$	fa' = fa x 0.65			Nazaroff and Doyle 1985
Chemical Concentration in Air (CA)	mg/m^3	CA=(fa' x 10^6 cm^3/m^3)/(V/A x ER)			USEPA 1999c
Attenuation Factor (AF)	dimensionless	AF = CA ug/m^3 /(1,000 L/m^3 x Kh x CW ug/L)			USEPA 2002

	PCE							TCE						
Address	CW ug/L	CW mg/cm^3	SG mg/cm^3	fa mg/cm^2-s	fa' mg/cm^2-s	CA mg/m^3	AF dimensionless	CW ug/L	CW mg/cm^3	SG mg/cm^3	fa mg/cm^2-s	fa' mg/cm^2-s	CA mg/m^3	AF dimensionless
Home #6	50	5.0E-05	3.8E-05	9.8E-10	6.4E-10	3.8E-02	1.0E-03	20	2.00E-05	8.40E-06	2.41E-10	1.57E-10	9.22E-03	1.10E-03
Home #4	0.01 U	--	--	--	--	--	--	15	1.50E-05	6.30E-06	1.81E-10	1.18E-10	6.92E-03	1.10E-03
Home #7	10	1.0E-05	7.5E-06	2.0E-10	1.3E-10	7.5E-03	1.0E-03	10	1.00E-05	4.20E-06	1.21E-10	7.84E-11	4.61E-03	1.10E-03

Notes:
-- AFs cannot be calculated where chemicals were not detected in groundwater.

Table B-5
Site-Specific Concentration Attenuation Factors (Groundwater to Indoor Air)

$AF = CA / (1{,}000\ L/m^3 \times H \times CW)$

AF	attenuation factor (unitless)	calculated
CA	Indoor Air Concentration (ug/m^3)	site-specific
CW	Groundwater Concentration (ug/L)	site-specific
H	Henry's Law Constant (unitless)	chemical specific
		TCE = 0.422
		PCE = 0.754

Address	Indoor Air Concentrations		Groundwater Concentrations(1)		Attenuation Factor	
	TCE	PCE	TCE	PCE	TCE	PCE
	ug/m^3	ug/m^3	ug/L	ug/L		
Home #1	--	--	1	0.01 U	--(2)	--(2)
Home #2	1 U	1 U	0.02 U	0.01 U	--(2)	--(2)
Home #3	1 U	1 U	0.02 U	0.01 U	--(2)	--(2)
Home #5	1 U	1 U	0.02 U	0.01 U	--(2)	--(2)
Home #6	1 U	1.8	20	50	1.18E-04	4.8E-05
Home #4	3.1 2.2 2.65	1 U	15	0.01 U	4.19E-04	--(2)
Home #7	1 U 1 U	1.8 2.1	10	10	2.37E-04	2.5E-04
average =		1.9				

Note: U values indicate no detection
-- indicates no sample collected
(1) concentration information interpolated from isopleth maps.
(2) No AFs can be calculated where chemicals were not detected in groundwater.

Table B-6
Groundwater Concentrations from Air Cleanup Levels at Various Attenuation Factors

Chemical of Concern	AF Source	calculated AF (unitless)	MTCA Method B CA (ug/m^3)	acceptable SG (ug/m^3)	acceptable CW (ug/L)
TCE (Henry's Law Constant = 0.422)	Home #4	4.19E-04	0.02	52.3	0.12
	Home #6	1.18E-04	0.02	184.6	0.44
	Home #7	2.37E-04	0.02	92.3	0.22
	J-E Model	1.30E-04	0.02	168.3	0.40
	Farmer Model	1.10E-03	0.02	19.9	0.05
	Home #4	4.19E-04	1.46 (1)	3487.5	8.26
PCE (Henry's Law Constant = 0.754)	Home #6	4.77E-05	0.4	9163.2	12.2
	Home #7	2.52E-04	0.4	1736.2	2.3
	J-E Model	1.20E-04	0.4	3645.8	4.8
	Farmer Model	1.00E-03	0.4	437	0.6
	Home #7	2.52E-04	4.38 (1)	17381.7	23.1

Formulas:
SG = CA / AF
CW = SG / (Henry's Constant x 1,000 L/m^3)

Notes:
AF - Attenuation factor
J-E - Johnson and Ettinger Model for Subsurface Vapor Intrusion
CA - Chemical concentration in air
SG - Chemical concentration in soil gas
CW - Chemical concentration in groundwater
MTCA - Model toxics control act

(1) - These MTCA Method B values are the old Method B values that were used in the original report. Acceptable groundwater concentrations were calculated using the highest empirical AF.